SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

MAY 1898.

GENERAL PHYSICS.

471. *Forms of Energy.* **A. Vaschy.** (Écl. Électr. 13. pp. 5–14, 1897.)—The author discusses the experimental properties of energy in its different forms, for example as kinetic and potential energy, heat energy, energy of elasticity, chemical energy, electric and magnetic energy. W. R. C.

472. *Deformation of Metals.* **Mesnager.** (Comptes Rendus, 126. pp. 515–517, 1898.)—The lines which appear on the surface of iron subjected to deformation ("Luders' lines") have been found by Hartmann to occur on all metals. When the limit of elasticity is passed, there are generally two systems of curves crossing one another at constant angles, with possibly a third system of lines bisecting the former two. Below as well as above the limit of elasticity, the action of a weak acid will render these lines manifest when the metal is under stress. The two former sets of lines are bisected by the direction of the greatest tension. The formation of these lines is accompanied by slip of the material. A sketch is given of a mathematical theory of these phenomena. A. D.

473. *Residual Torsion in Soft Iron.* **H. Bouasse.** (Comptes Rendus, 126. p. 585, 1898.)—In this note the author shows that the two laws announced by Moreau with respect to the residual torsion in soft iron are easily deduced from known facts. J. B. H.

474. *Measurement of Torsional Angle of a Rotating Shaft.* **F. J. Jervis-Smith.** (Phil. Mag. 45. pp. 183–185, 1898.)—The method is as follows:—Two discs of insulating material are fixed at the ends of the shaft, and narrow slips of copper are attached to the discs at their circumferences, and to the shaft. Two brushes (single flat wires answer well) press on the edge of the discs,

the brushes are connected to an electric circuit, including a battery and a telephone. When the slips of copper are in the same plane, at each revolution of the shaft a click is heard in the telephone; but if while the shaft is rotating the disc at one end has an angular advance on the disc at the other end, due to torsion, no click will be heard, since the slips do not touch the brushes at the same instant. Now, in order to hear the click again, the brush-holder must be rotated through an angle equal to the angle of torsion, which is thus found.

The author has applied the method to find the torsional angle of an ergometer in which a solenoidal spiral spring is used instead of a shaft.

The couple due to any angle is found by fixing one end of the shaft and suspending known weights from a thin steel tape attached to a pulley of known radius keyed on to the shaft close to the disc. AUTHOR.

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475. *New Vacuum-Pump.* **J. Tuma.** (Wien. Akad. Sitzber. 106. pp. 473–480, 1897.)—In view of the constantly increasing experimental work connected with X-rays, instruments by means of which the required high vacua can be produced have become of great interest. The new mercury-pump illustrated and described in this paper is based upon the Sprengel-type, and fulfils the following important requirements:—(1) Simplest possible construction; (2) constant readiness for use and durability of parts attained chiefly by the exclusion of rubber; (3) facility of repair, even with ordinary glass-blowing experience; (4) high efficiency: a volume of half a litre can be exhausted in 30 minutes to Crookes' vacuum, and with continued exhaustion and heating, the highest at present attainable vacua are effected. These pumps are manufactured by the 'Glühlampenfabrik 'Watt'' in Vienna, and their cost is about 60 florins (about £4 10*s.* 0*d.*). S. G. R.

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476. *Decimal Time and Decimal Circular Measurements.* **J. de Rey-Pailhade.** (Comptes Rendus, 126. pp. 505–507, 1898.)—The author once more proposes to divide the day of 24 hrs. into 100 parts called *cé*, each of 14 min. 24 sec. (approximately one quarter of an hour), and to subdivide into deci, centi, milli, and demi-cés. The millicé would be 0·864 sec., the new unit for physical determinations. Similarly the whole circumference (4 R) is to be divided into 100 *cirs*, symbol *κ*, each of 3° 36′ or 4 grades; the dimicir would be 1·296″. November 2565·3 *cés* would signify, 25th of November at 65·3 *cés*. This system of notation has already been used by Tisserand and also by Aitken and Schaeberle. The agreement between time and longitude would simplify many calculations. The author has prepared tables for astronomical, geographical, and physical calculations based upon this system, and Mendizabal-Tamborrel has worked out the logarithms of these circular functions to 7 or 8 places. H. B.

477. *Lines of Force and Equipotential Surfaces in Nature.* **G. M. Stanoiévitch.** (Comptes Rendus, 126. pp. 640–643, 1898.)—The similarity in form between diagrams of lines of force and equipotential surfaces in electrical and magnetic phenomena and certain natural patterns are pointed out and examples given.

Thin plates of non-axial and biaxial crystals, the section of an oak-tree just below a ramification, and also a deal plank with two knots, show patterns which bear a strong resemblance to well-known diagrams. The author thinks that the resemblance is not merely accidental, but is due to the action of definite forces.

R. S. C

478. *Sailing Flight.* **Bretonnière.** (Revue Scientif. 9. pp. 33–40, 1898.)—The author considers that falcons, having fallen through a certain height, can describe a semicircle and then rise again to almost the same height, simply by changing their direction without moving their wings; and that, in a similar way, they can pass from a horizontal into an upward, and from a downward into a horizontal motion. Gulls are said to do the latter when they find their prey escape on approaching the water-level. The chief part of the paper deals with sailing flight against a uniform, horizontal wind, as to which he had been attacked by O. Chanute (Aëronautical Journal, 1897) and by Soreau, and which he explains in the following way:—A bird perched on a pole rises a little by the force of its wings, drifting backward with the wind, which it faces; it then shoots down at right angles to the wind and, facing the current again under a small angle, is borne to a greater elevation than it started from. This process may be repeated, the bird falling in a short steeper curve and rising again under a small inclination. The bird would thus appear to sail on a kind of breaker-wave. The author has not himself observed this sailing, but he quotes Basté and also Chanute as authorities for part of his hypothesis. For his calculations he makes use of Lilienthal's tables on the air-reaction against concave surfaces having a rise of arc equal to one-twelfth of the wing-breadth. But he regards the data as too uncertain. If a is the vertical and b_1 the horizontal component of the bird's velocity against a horizontal wind b_2, and $b=b_1+b_2$, then the hypotenuse c of a right-angled triangle, whose sides are a and b, would represent the descending air-current which the bird has to overcome and against which he sails under a small angle. For the descent of the bird, c would be an ascending current. This c is Bretonnière's "rafale relative." He does not share the opinion of most scientists that for the sailing bird a uniform air-current is equivalent to a calm.

H. B.

479. *Psycho-Physical Law.* **Casslant.** (Revue Scientif. 9. pp. 171–176, 1898.)—The psycho-physical law expresses the relations between the intensity of a force (light, sound, heat) exciting our nerves and the resulting sensation. By experimenting with

lanterns provided with diaphragms of different apertures and with photometers, Ch. Henry has arrived at curves corresponding to the formula $S=K(1-e^{-\lambda i^m})$, in which S is the order of the sensation, i the apertures, and K, λ, m are the parameters of an exponential curve. The parameters vary for different individuals and different states of the eye. The experimenter started with the weakest source of light perceptible, and increased the light intensity gradually. A similar formula was obtained for the light reflected from differently coloured bands; the intensity comparison was made by covering the white field next to a coloured band with strips of gelatine until the difference disappeared. In the acoustic experiments, a watch was placed in a copper tube behind a diaphragm, between which and the watch cushions of cotton-wool and ebonite discs provided with apertures (radii from 1 to 4 mm.) were interposed. The same type of curve resulted. In the heat tests two vessels were filled with liquids of different temperatures, the hands, which were frequently changed, dipped in, and the one or other liquid cooled or heated until both had the same temperature. The temperature varied between +60° and −60° C. Two curves were obtained, one for heat and one for cold sensations, both starting from 15° C., and both again exponential, but with different parameters. Marius Blix has indeed assumed the existence of special nerves for heat and cold. In a certain sense, the other sensations also appear to be double, as if there were special sensations for light and darkness, for sound and silence. The time element, of course, enters into all three sensations, and the complete equation is $S=K(1-e^{-\lambda i^m})(1-e^{-\alpha i^n t})$. The formulæ are not well printed, so that it is difficult to distinguish the indices from the other letters, and the methods of procedure are not fully explained. H. B.

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480. *Mathematical Conception of Space.* **A. Muller.** (Revue Scientif. 9. pp. 202–207, 1898.)—The title of this paper is misleading. Muller simply wishes to facilitate our forming ideas of astronomical magnitudes. For the solar system, he uses the diameter of the earth, 12,735 km., as unit of length, which he represents by 1 mm. For the nearest fixed stars, he further reduces the scale to one thousandth of that value. H. B.

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481. *Photography of Ripples.* **J. H. Vincent.** (Phil. Mag. 44. pp. 411–417, 1897, and 45. pp. 191–197, 1898.)—The author first describes an apparatus for producing the photographs. The ripples are due to the agitation of the surface of the mercury by styles attached to tuning-forks. The light used is that of a Leyden-jar spark. It is rendered parallel before incidence on the mercury surface, and only that light which was reflected in a parallel beam was allowed to fall on the sensitive plate. The lens of the camera was provided with a very small stop.

The method is used to find the surface-tension of ordinarily clean mercury. The paper then consists of a description of a dozen half-tone reproductions of ripple photographs. They chiefly illustrate in order the following:—(1) Fresnel's bands. (2) Moving elliptical interference-bands. (3) Meslin's bands. (4) Moving bands due to beats. (5) Ripples due to two styles vibrating with widely differing frequencies. (6) Lloyd's fringes. (7) Moving elliptical bands due to reflection. (8) Shallow circular mirror. (9) Spherical aberration. (10) Concave reflector. (11) Principal focus of circular mirror. (12) Diffraction.

Many other phenomena met with in wave-motion are described.

In the second paper similar results are given. The apparatus is slightly modified. The photographs illustrate the following:—(1) Ripples due to shaking of the sides of the trough by sound. (2) Shaking due to stamping with the foot on the floor of the laboratory. (3) Conjugate foci of circular reflector. (4) & (5) Abnormal foci. (6) Elliptical reflector. (7) Elliptical reflector with source at its centre. (8) Diffraction grating. (9) Zone plate. (10) The focal length of a zone plate is less for longer waves. (11) Refraction of ripples by a triangle of water. (12) Refraction of ripples by a series of circular drops of water.

AUTHOR.

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482. *Seismograph with Time Recorder*. **L. Pfaundler.** (Wien. Akad. Sitzber. 106. pp. 551–561, 1897.)—The author considers that the time recorders of seismographs leave something to be desired. Registration on a tape is out of question, since a paper-feed of 40 m. per day would be required to obtain legible records, representing seconds by spaces of 0·5 mm. He photographs the dial of a watch in the moment of the concussion. The watch is fixed in the door of the camera-box, and is illuminated by two small glow-lamps, whose circuit is closed by the shock. The contact apparatus consists of a vertical steel-rod ending above in a little brass cup holding a common marble. The upper end of the rod is surrounded by a funnel, closed at the bottom by a cap attached to a lever. The falling marble turns the lever, against whose journal, part of which is insulated, a contact-spring bears. This spring closes the circuit of three small accumulator cells. The marble rolls into a second trough, whose turning lever causes an alarm-bell to ring, until the observer puts the ball back into its cup on the steel rod. The observer also changes the dry plate, after which a fresh time-record can be made. The watch has to be wound up, but otherwise the apparatus requires no attendance. The four different parts of the apparatus are connected by wires only, and may be in different rooms. The drawback of the device is that two consecutive automatic time-records cannot be obtained, so that, of rapidly following concussions, only the first will be timed. This might be remedied, *e.g.*, by making the photographic plate revolve slowly. Pfaundler does not desire to complicate his device, however.

H. B.

483. *Propagation of Earthquake Oscillations.* **M. P. Rudzki.** (Akad. Wiss. Cracow, pp. 354–355, 1897.)—This is a mathematical deduction, given in abstract only, based upon A. Schmidt's hypothesis that the propagation of earthquake oscillations is a decreasing function of the earth radius. The apparent rate with which the waves spread on the earth surface is infinite at the epicentre; that is to say, all points near the epicentre are shaken at the same moment. Further away from the epicentre, the rate decreases in all directions, and attains its minimum at a certain distance; the equation for this circle has been deduced. Beyond that circle, the rate increases again. The diameter of the circle depends upon the depth of the earthquake origin. When the depth is insignificant, the circle will be represented by the epicentre; the greater the depth, the larger the area of decreasing apparent rate of surface propagation. When the earthquake originates in the centre of the earth, there will be no area of decreasing or increasing rate of propagation; the rate will be infinite everywhere, since all points of the surface will feel the concussion simultaneously. H. B.

484. *Lecture Experiment on Air-Pressure.* **E. Warburg.** (Berlin. Phys. Gesell. Verh. 17. pp. 21–22, 1898.)—That the air-pressure decreases at higher elevation can easily be demonstrated in the following way:—An ordinary Argand gas-burner, connected with the gas-pipe by a long rubber tube, is suspended so that it can be raised by 4 m. In the higher position the flame ought to be larger, since the light gas is less influenced by gravity than the heavier air. The difference is not striking enough, however. But when the gas pressure is first reduced, with the help of a Mariotte bottle, to about 10 mm., the flame will on the table appear blue, and become larger by 30 per cent. and luminous on raising the burner. H. B.

LIGHT.

485. *Interferential Spectroscope.* **Ch. Fabry** and **A. Perot.** (Comptes Rendus, 126. pp. 331–333, 1898.)—The instrument has been previously mentioned in Abstract No. 23, Jan. 1898, and the present paper is devoted to a more complete description. The interference bands produced between two silvered glass surfaces adjusted to exact parallelism are observed, their form in this case being circular. Provision is made for varying the distance between the two surfaces without disturbing their parallelism, the separation being read off directly on a half-millimetre scale. Fine adjustments are obtained by the flexure of a plate of steel caused by a column of water in an indiarubber tube. Comment is made upon the conditions necessary for the best results, upon the thickness of the silvering on the two glass plates, and the necessity of using a small source of light. A single plate of glass with both its faces silvered may be employed, one advantage of this being that, for the same dispersion, the bands are more separated, and therefore more easily observed. A serious disadvantage is the invariability of the difference of path of the interfering pencils, and also the great care necessary to work the two surfaces exactly parallel to each other. C. P. B.

486. *Spectral Lines.* **A. Perot** and **Ch. Fabry.** (Comptes Rendus, 126. pp. 407–410, 1898.)—The authors have used their interferential method of comparing wave-lengths (Ann. de Chim. et de Phys. Dec. 1897) for a study of the spectral lines of some metals. The thallium line they find is composed of one principal radiation and two feeble radiations of longer wave-lengths and of approximately equal intensities. The intervals between the wave-lengths of the principal and the feeble rays are 3×10^{-6} and 21×10^{-6} of the principal wave-length. The green mercury band they also find to be triple, the feeble components being of greater wave-length than the principal component. The intervals between the principal and feeble components are 17×10^{-6} and $1{\cdot}5 \times 10^{-6}$ of the principal wave-length. The green band of cadmium is found to be double, the feeble ray being of shorter wave-length $\left(\frac{\Delta\lambda}{\lambda} = -5 \times 10^{-6}\right)$. The blue cadmium band is triple, the two feeble radiations being equally distant on opposite sides of the principal band, and for both $\frac{\Delta\lambda}{\lambda} = 17 \times 10^{-6}$. J. B. H.

487. *Dissociation Spectra of Fused Salts.* **A. de Gramont.** (Chem. News, 77. pp. 28–29, 1898.)—In continuation of a previous paper in the Ann. Chim. Phys., ser. 7, vol. x. Feb. 1897, the author

gives the measurement of the chlorine lines in the chlorides of Na, Li, K, Cd, and Zn, all of which easily showed the haloid spectra when not effaced by brilliant metallic lines. The different groups are characteristic from an analytical point of view, and are sharper in the melted compounds with the condenser-spark than in tubes with the free element. With only 0·0001 grm. of chlorine the groups Clγ and Clζ were still visible. The nomenclature of M. Salet (1873) is used throughout the paper.

Bromine.—M. Salet's multiple lines Br β, γ, δ, and ϵ, are found by the author to be single—while Br η and θ are much brighter than Salet described. The most characteristic lines in melted salts are Br ν, μ and ζ, in order of importance.

Iodine is richer in lines than Cl or Br, especially in orange-red. The most sensitive are Iη, Iμ, and Iζ_2 (546·6). S. G. R.

488. *Ultra-Violet Spark-Spectra.* **F. Exner** and **E. Haschek.** (Wien. Akad. Sitzber. 106. pp. 494–520, 1897.) (For previous papers see Phys. Soc. Abstracts, 1896, No. 449; 1897, Nos. 73, 301, 302, 526, and 653, and Science Abstracts, No. 365).—For K, Na, Ba, and B, compounds such as K_2CO_3, Na_2CO_3, $Ba(OH)_2$, and B_2O_3, fused on gas carbon terminals, had of necessity to be used instead of the elements. Photographs could not be taken on account of the interference of the carbon bands. 59 lines (between $\lambda = 4505·55$ and 2549·6 AE) were measured for K, only 5 lines (3303·13 – 2680·3) for Na, 168 lines (4726·64 – 2255·0) for Ba, and 8 lines (3451·4 – 2266·47) for B.

Iron.—2270 lines were measured and photographed in the ultra-violet between $\lambda = 2068·25$ and 4736·96 AE. Whilst Kayser and Runge found in their iron spectrum many hundred lines belonging to impurities such as Ni, Co, Cr, Mn, the authors have only found 14 foreign lines, attributable to traces of Ca, Mg, Ba, Mn, Cu, and Si. This exceptionally pure iron had been prepared in a pulverulent form by Prof. H. Weidel, and was condensed into a coherent mass by a pressure of 1000 atmospheres in a special steel apparatus.

S. G. R.

489. *Röntgen Rays and Germination.* **Maldiney** and **Thouvenin.** (Comptes Rendus, 126. pp. 548–549, 1898.)—The rays are found to have a remarkable influence in promoting germination. *Convolvulus arvensis* seeds, exposed to the rays for about an hour daily, germinated on the third day; these sheltered from the rays, but otherwise similarly situated and at the same temperature, germinated on the sixth day. *Lepidum sativum*, 49 hours and 6 days. *Panicum miliaceum*, 6 days and 16 days. The rays were from a Chabaud tube, 8 amperes, at 8 cm. from the seeds. There was no heating-effect due to the rays. The chlorophyll was absent at first just as under ordinary circumstances. A. D.

490. *Röntgen Rays and Osmosis.* **H. Bordier.** (Comptes Rendus, 126. pp. 593–596, 1898.)—The influence of Röntgen rays on osmosis was investigated by allowing the rays to fall on the animal parchment membrane of an osmometer which had a solution of sugar or salt inside, and was placed in a vessel of water. The rate of rise of the liquid in the osmometer tube was noted when Röntgen rays were present, and also when absent; and in every case the rate of rise was diminished by the rays, the diminution amounting to from 25 to 50 per cent. The author thinks this may possibly lead to an explanation of some of the observed therapeutic effects produced by the rays. J. B. H.

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491. "*Secondary Rays*" *from Air.* **G. Sagnac.** (Comptes Rendus, 126. pp. 521–523, 1898.)—The secondary rays produced by transformation of Röntgen rays on impact upon a solid are produced not only at the surface of the impact, but also at that of exit. In the case of gold the thickness of the metal whence these rays come is about 0·5 μ; in that of aluminium about 1 mm., 2000 times as great. In such a substance as air the two layers overlap, and the secondary radiation from the air is in all directions; but the secondary rays from air are less penetrating than the direct Röntgen rays of which they are the transformation. The phenomenon is not analogous to light scattered by tobacco smoke, but to a beam of light sent through a solution of fluorescein. A. D.

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492. *Diffraction and Photographic Network Screens.* **Ch. Féry.** (Comptes Rendus, 126. pp. 333–335, 1898.)—The spreading of each point of light into the shadows is not due to diffraction; for with a camera-length of 30 cm. and a network screen at 3 mm. from the sensitive plate, the fringes could not be wider than 0·03 mm., and would disappear in the reduction and intensification; and further, all the fringe-effects would disappear if the source of light instead of being a point, was 3 mm. across, and would blend into a general penumbra effect. A series of experiments is described, confirming these conclusions. To get the black diffraction-cross it is necessary to set the screen at 15 mm. from the sensitive film, and to use a source of light 0·5 mm. in diameter. When the black cross is at its maximum, $a^2/4=e\lambda-e^2\lambda/F$, where a is the width of a clear space in the screen, e the distance between the screen and the sensitive plate, F the camera-length, and λ the wave-length; or, approximately, $e=a^2/4\lambda$, so that the distance between the screen and the plate, in order to produce the most marked black cross, is independent of the camera-length and of the diaphragm, conditions which nevertheless do affect the clearness of the definition. A. D.

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493. *Action of Thermic Poles on Photographic Plates.* **A. Guebhard.** (Comptes Rendus, 126. pp. 589–592, 1898.)—This paper

contains an investigation of some phenomena described by the author in a former paper (C. R. 125. pp. 814–819, 1897), connected with the action of thermic poles on photographic plates when in the developing bath. In certain positions of the plate a black spot on the plate would show where the hot pole had acted, while in other positions the spot would be white. The plates also showed a striated appearance, the striæ being along the lines of flow of heat. The author finds that the appearances are fully accounted for by the convection currents. The black spots correspond to the places where the circulatory movement of the liquid tends to bring the molecules against the film, and the white spots to the places where the movement tends to detach them from it.

J. B. H.

494. *Radiation Phenomena in a Magnetic Field.* **P. Zeeman.** (Phil. Mag. 45. pp. 197–201, 1898.)—This is a preliminary account of measurements of the separation of the outer components of the Zeeman triplet. The results, so far, show that for different substances in the same field the interval (in wave-lengths) is of the same order of magnitude, and certainly not directly dependent upon the atomic weight. But the variation with wave-length seems more complicated than it would be on Larmor's hypothesis.

The results for zinc are:

λ.	Distance between components in $\frac{1}{100}$ millim.	Scale of negative.	Order of Spectrum.
4811	18·6	1 millim. =4·41 A.U.	2
4722	20·7		
4680	25·1		
3345	Imperceptible	1 millim. =2·94 A.U.	3
3303	....		
3282	0		

In both sets $H=32.10^3$. It is noticeable that the first three lines result from Kayser and Runge's *second* subordinate series for $n=3$ (Wied. Ann. 43. p. 394). The second three belong to the first set for $n=4$.

Results for cadmium, copper, and tin are also given. The author intends to repeat the experiments with an improved apparatus.

G. B. M.

495. *Absorption of Light in Crystals.* **J. Ehlers.** (Neues Jahrbuch für Mineralogie, Geologie und Paleontologie, 11. 1897.)—The experiments relate to plates of the following crystals, cut as indicated.

Tourmaline.—One plate parallel to the axis, one perpendicular to it, one at 47°, and one at 43° 30′.

Smoky quartz.—One parallel to axis, one perpendicular to it, one at 30°, and one at 60°.

Double sulphate of copper and cobalt.—Two perpendicular to the bisectors of the axes, one parallel to the plane of the axes, one at 14° to the first bisector.

Double sulphate of potassium and cobalt.—As in last; the fourth, however, being at 22° 30′.

Double sulphate of ammonium and cobalt.—One plate perpendicular to the first bisector, two, of different thicknesses, perpendicular to the second.

Using König's spectrophotometer, the author determines for both ordinary and extraordinary rays the index of refraction for wave-lengths ranging from 0·486 μ to 0·687 μ, and also the coefficient of absorption and its variation with the incidence. The conclusion arrived at is that in the plane of crystallographic symmetry there are two directions of maximum and minimum absorption, at right angles to each other, but not related in any simple way to the axes of symmetry. G. B. M.

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496. *Determination of the Sense of a Circular Vibration.* **A. Cotton.** (Journ. de Physique, 7. pp. 81–85, 1898.)—Two methods are explained:—(I.) Take a nicol which only allows to pass vibrations OP in the plane of its principal section; superpose a Fresnel parallelopiped with its plane of symmetry OA distant 45° from OP. This gives circular vibrations the sense of which is that in which an observer receiving the emergent ray would turn OA through 45° to make it coincide with OP. (II.) Between a nicol and a *circular* polariser (or analyser) put a plate of Iceland spar cut perpendicular to the axis. Near the centre of the ring-system thus produced are seen two black spots, the line joining which makes 45° with the principal section of the nicol, on one side or the other, according to the sense of the circular vibration. The author has confirmed Cornu's specification of the sense of the Zeeman rotatory effect observed along the lines of force.

G. B. M.

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497. *Calcite and Glass Nicol Prisms.* **C. Leiss.** (Berlin. Akad. Sitzber. 40. pp. 901–904, 1897.)—Iceland spar has become so rare, that the nicols have had to be replaced by Nörrenberg sets of glass plates in saccharimeters, microscopes, and other apparatus. Since 1884, attempts have also been made to substitute crystals of nitre and potassium chromate for calcite. Plates of these salts are fixed between two wedges of glass; but good crystals of large size and suitable cements are difficult to obtain, and the colour of the chromate is objectionable. Leiss makes the second half of a nicol of glass of the same shape and refractive and dispersive power as calcite. As perfect agreement cannot as yet be realised, however, he recommends such compound nicols more as polarisers than as analysers. In his analyser, the extraordinary ray is very slightly deflected, so that the object appears to oscillate a little when the analyser is turned. The paper does not give any particulars.

H. B.

498. *Photometry of Mirror Projectors.* **A. Blondel** and **J. Rey.** (Comptes Rendus, 126. pp. 404–407, 1898.)—The authors deduced from theoretical considerations that the brilliancy of any point of the surface of the mirror of a mirror-projector of the form due to Mangin is practically constant, each point being considered as a source of light, and its brilliancy being measured in the direction of the optic axis of the mirror. They have now tested this experimentally, and find that the brilliancy is constant except at the edges of the mirror and the central portion which is hidden by the negative carbon. To determine the brilliancy at any point of the surface, a sheet-iron screen was introduced a short distance in front of the projector so as to cut off all the rays except those coming from a small area surrounding the point. These rays passed through a small hole in the sheet-iron screen, and formed an image of the crater on a photometer-screen interposed at some distance. The illumination at the centre of this image was measured, and the brilliancy at the point of the mirror calculated. By finding the brilliancy of each zone of the mirror the total candle-power of the projector is easily deduced. Thus the experimental determination of the candle-power of search-lights can be performed without leaving the laboratory. J. B. H.

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499. *Aerial Graphoscope.* **E. S. Bruce.** (Soc. Arts Journ. 46. pp. 201–210, 1898.)—A lath is rotated about its centre in its own plane, and a picture projected upon it by a magic lantern. The apparatus illustrates persistence of vision, and may be used for testing it quantitatively. Three tables of numerical results are given. The inventor suggests that the apparatus may be used for stage effects such as the dagger in 'Macbeth.' G. B. M.

HEAT.

500. *Fusibility of Foundry Iron.* **T. D. West.** (Eng. 65. pp. 287–288, and pp. 319–320, 1898.)—The author has, from a practical standpoint, carefully tested the fusibility of grey and chilled irons. He does not give the melting-points nor the latent heats of fusion (perhaps such things are useless from the varying conditions of an experiment), but finds that chilled iron when placed in a cupola takes distinctly *less time* to melt than iron which has been cast in sand. The tests are not confined merely to the determination of fusibility, but the chemical changes due to remelting, the shrinkage and contraction on casting, are also studied. The experiments show that chilled iron gives a softer iron on remelting than grey iron. A. Gs.

501. *Measurement of High Temperatures.* **D. Berthelot.** (Comptes Rendus, 126. pp. 410–412, 1898.)—The principle of the method employed depends on the fact that if the density of a gas is diminished by a certain fraction either by diminution of pressure or by rise of temperature, the refractive index of the gas takes the same value in the two cases. A beam of light is divided, one half traversing a tube of air in which the pressure can be varied and measured, the other half traversing a tube of air which can be heated electrically by a coil of wire surrounding the tube; the two halves are then recombined, so as to give interference-fringes. The pressure of gas in one tube is varied so as to counterbalance any motion of the interference-bands due to rise of temperature in the other, and the rise of temperature is then calculated from the variation of pressure. To eliminate the variations of temperature along the tube a differential method is employed, by which only the influence of a certain length of the middle portion of the air-column in which the temperature is constant, is measured. An accuracy of 1° up to the temperature of fusion of gold is claimed.

J. B. H.

502. *Measurement of Thermal Conductivity in Crystals.* **W. Voigt.** (Journ. de Physique, 7. pp. 85–90, 1898.)—Suppose x, y, z, the directions of the axes of thermal symmetry in a crystal, are known. A plate is cut parallel to the plane xy, and in the shape of a rectangle whose sides are parallel to the bisectors of the angles contained by x, y. The rectangle is then bisected along a line parallel to two of its edges, and the two halves are cemented together after turning one of them through 180°. The plate is now covered with a mixture made by adding to elaidic acid about $\frac{1}{4}$ of its weight of de Sénarmont's compound of wax and turpentine. When the plate is warmed by a source of heat, symmetrical with respect to the central line, isothermal lines are produced at the edge of that part of the mixture which is melted. The isothermals

meet on the central line at a constant angle ψ, and the principal conductivities, λ_1, λ_2 in the plane xy are connected by the relation

$$\lambda_1/\lambda_2=\left(1\mp\tan\frac{\psi}{2}\right)\Big/\left(1\pm\tan\frac{\psi}{2}\right).$$

The method of isothermals may also be usefully applied to determine the relative conductivities of isotropic bodies—*e. g.*, bad conductors or rare substances. G. B. M.

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503. *Transmission of Radiation by Gases.* **C. F. Brush.** (Phil. Mag. 45. pp. 31–42, 1898.)—Dulong and Petit concluded from their experiments that the rate of cooling due to the presence of a gas at pressure p varies as p^a, where a is a constant less than 1 which differs for each gas. The author's observations show that this can be approximately true only when the cooling occurs in a relatively large space and the pressure is not less than, say, $\frac{1}{50}$ atmosphere. He placed a thermometer-bulb in the middle of a reservoir whose sides were kept at 0°, and observed its times of cooling from 15° to 10°, from 9° to 6°, from 6° to 4°, and from 3° to 2°; the reciprocals of these times (which were taken as the measure of the rates of cooling) were then plotted on a diagram with pressures for abscissæ. If Newton's law were true, the four lines so drawn for any gas would be coincident, since the time of cooling from one temperature to another would be proportional to the logarithm of the ratio of these temperatures, and this ratio is the same for all the pairs of temperatures taken. Such coincidence was, however, observed in only one or two cases, and then only at extremely low pressures; in general the curves lay in order one below the other, that for the 15°–10° range being the highest.

Experiments were made with air, carbon monoxide, ethylene, hydrogen, and carbon dioxide, and two forms of reservoir were employed—one fairly large, and the other little larger than the enclosed thermometer. With the larger reservoir the curves were convex upwards till about $\frac{1}{20}$ atmosphere, were then parallel to the p-axis or slightly concave upwards till about $\frac{1}{500}$ atmosphere, and then bent downwards again with exceeding rapidity. With the small bulb the curves were quite changed in shape, being nearly straight or slightly concave upwards till about $\frac{1}{50}$ atmosphere and then bending quickly downwards. Admixture of CO_2 with H was found to interfere very greatly with the cooling power of H. R. E. B.

ELECTRICITY.

504. *Magneto-Optic Phenomena.* **C. H. Wind.** (Phys. Rev. 6. pp. 43–51, 1898.)—The writer proposes to show how, starting from Maxwell's field equation, we may, by assuming a certain relation between the electric force and electric current in a magnetic field, explain mathematically both the Hall effect and the Kerr effect. First, assuming an isotropic field in which no external magnetic force acts, any disturbance is represented by

$$A\epsilon^{-\frac{2\pi i}{T}(t-R[x\sin\phi+\eta\cos\phi])}=AP.$$

The fundamental equations in this case are, in the usual notation,

$$\text{Div. }\mathbf{E}=0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{I.}$$

$$(\mathbf{E}_n)_1=(\mathbf{E}_n)_2, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{II.}$$

n being the normal to a surface of separation of two media:

$$\text{Rot. }\mathbf{H}=4\pi\mathbf{E} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(A)}$$

$$\text{Div. }\mathbf{H}=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{III.}$$

$$(\mathbf{H}_n)_1=(\mathbf{H}_n)_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{IV.}$$

$$\mathbf{H}_{h1}=\mathbf{H}_{h2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{V.}$$

h being a line in the surface of separation.

The electric force satisfies

$$\text{Rot. }\mathbf{F}=-\frac{d}{dt}.\mathbf{H} \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(B)}$$

$$(\mathbf{F}_h)_1=(\mathbf{F}_h)_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{VI.}$$

and

$$\mathbf{E}=p\mathbf{F}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (37)$$

where p is a known complex constant.

The question then arises what modification must be made in these equations when there is an external magnetic force $\mathbf{N}$. It is proposed, in order to solve this problem, to leave equations I. and II. unaltered—to understand (A) and III., IV., V., as merely defining the vector $\mathbf{H}$. There remain only B, VI., and (37). It has hitherto been usual to write

$$\mathbf{F}=\frac{1}{p}\mathbf{E}-q[\mathbf{NE}], \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{(C)}$$

$[\mathbf{NE}]$ denoting the vector product of $\mathbf{N}$ and $\mathbf{E}$, and q denotes a *real* constant. Our author proposes to make q a *complex* constant, which he says completely explains the phenomena in a medium which is magnetised in the plane of incidence. Substitute the value of $\mathbf{F}$ given by (C) in B, and apply I. Then B becomes

$$\frac{1}{p}\text{Rot. }\mathbf{E}+q\mathbf{N}\frac{\partial}{\partial z}\mathbf{E}=-\frac{d}{dt}\mathbf{H}, \quad . \quad . \quad . \quad . \quad \text{(B}a\text{)}$$

the axis of z being the direction of $\mathbf{N}$. Then he finds

$$\alpha = -\mathrm{R}\cos\phi\left(\frac{1}{p}b - q\mathbf{N}a\cos\phi\right)\mathrm{P},$$

$$\beta = \mathrm{R}\left(\frac{1}{p}a + q\mathbf{N}b\cos\phi\right)\mathrm{P},$$

$$\gamma = \mathrm{R}\sin\phi\left(\frac{1}{p}b - q\mathbf{N}a\cos\phi\right)\mathrm{P},$$

a and b being two new constants. In result he obtains six sets of equations as follows:—

$$\mathrm{R}_0^2 = \frac{4\pi p}{}, \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad \text{(D)}$$

in which $\partial = -\frac{2\pi i}{\mathrm{T}}$;

$$\tfrac{1}{2}pq\mathbf{N} = \mu; \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad \text{(E)}$$

$$\mathrm{R} = \mathrm{R}_0(1 \mp \mu i\cos\phi); \quad . \; . \; . \; . \; . \; . \; . \quad \text{(F)}$$

$$\left.\begin{aligned} u &= a\cos\phi\mathrm{P} \\ v &= \pm\, ia\mathrm{P} \\ w &= -a\sin\phi\mathrm{P} \end{aligned}\right\}; \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad \text{(G)}$$

$$\left.\begin{aligned} \mathrm{X} &= \frac{a}{p}(\cos\phi \pm 2\mu i)\mathrm{P} \\ \mathrm{Y} &= \pm\, i\frac{a}{p}(1 \pm 2\mu i\cos\phi)\mathrm{P} \\ \mathrm{Z} &= -\frac{a}{p}\sin\phi\mathrm{P} \end{aligned}\right\}; \quad . \; . \; . \quad \text{(H)}$$

$$\left.\begin{aligned} \alpha &= \pm\, i\mathrm{R}^0\cos\phi(1 \pm \mu i\cos\phi)\mathrm{P} \\ \beta &= \mathrm{R}_0\frac{a}{p}(1 \pm \mu i\cos\phi)\mathrm{P} \\ \gamma &= \pm\, i\mathrm{R}_0\sin\phi(1 \pm \mu i\cos\phi)\mathrm{P} \end{aligned}\right\} \quad . \; . \; . \quad \text{(K).}$$

The equations (G), (H), (K), (D), (E), and (F) contain M. Wind's solution of the problem. S. H. B.

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505. *Contact Electrification.* **A. Coehn.** (Annal. Phys. Chem. 64. 2. pp. 217–232, 1898.)—Experiments on insulating solids and liquids, made by Faraday, Nernst, Drude, and the author among others, show that the bodies of high dielectric capacity assume a positive charge in contact with insulators of a lower dielectric capacity. This is probably a universal law, which sheds much light on the process of contact electrification itself. The case of conducting bodies has already been dealt with by Nernst's ionic mobility theory. It is interesting to note that diamond, which is positive with respect to all other solids, has probably a high dielectric capacity, as indicated by its high refractivity. E. E. F.

506. *Electrical Properties of Freshly Prepared Electrolytic Gases.* **J. S. Townsend.** (Phil. Mag. 45. pp. 125–151, 1898.)—The experiments which are described in this paper deal with the oxygen and hydrogen which are evolved electrolytically from dilute solutions of sulphuric acid and caustic potash. These gases carry with them electric charges which, to a large extent, remain in the gas after it has been bubbled through sulphuric acid or other solutions, or after the gas has been passed through glass-wool. The gases evolved from the sulphuric-acid electrolyte carry a positive charge, and those which are evolved from the caustic-potash electrolyte carry a negative charge. When the charged oxygen or hydrogen is moist a cloud is formed, which can be removed by passing the gas through sulphuric acid or a calcium chloride tube, but when the gas is passed through water the cloud appears again. Various experiments were performed to show that the drops which constitute the cloud are formed round the carriers of the electric charge. Thus, if the moist gas be passed along a horizontal tube, the charge in the gas will gradually be removed, whereas if the gas be dry the rate of loss of charge is very much slower. In the former case the cloud which is formed falls in the tube and carries with it the charge.

Both the density of electrification and the number of drops in the cloud are increased when the temperature of the cell from which the gases are evolved is increased. The relation connecting the weight of the cloud and the charge on the gas was found by the following method. The gas from the cell was passed through water at a known temperature. It thus acquired a known quantity of moisture and also a cloud. The stream of gas was kept uniform (by sending a steady current through the electrolyte) and, after leaving the water, was passed through a set of three bulbs containing sulphuric acid. By this means both the moisture and cloud were removed; and by finding the increase of weight of the bulbs and subtracting from it the calculated weight of the moisture, the weight of the cloud was obtained. As the gas escaped from the bulbs it entered an insulated inductor connected to a pair of quadrants of an electrometer, so that the charge on the gas could be determined by the deflection on the electrometer scale. The sulphuric-acid bulbs were also insulated, and connected to the quadrants so as to find the rate at which they acquired a charge as the stream of gas passed through them. By this means the density of the electrification of the gas entering the bulbs was found, being equal to the sum of the charges acquired by the bulbs and the inductor divided by the volume of the gas. Both the weight of the cloud per c. c. and the corresponding electrification were thus determined; and it was found that when the temperature of the electrolyte was raised, that both these quantities increased in such a way that their ratio remained constant.

This result was made use of to determine the charge on each of the drops in the cloud. The size of the drops was obtained by observing the rate at which the cloud fell, and the weight of each calculated. The number of drops per c. c. in the cloud was found by dividing the weight of the drop into the weight of the cloud per c. c.; the charge on each carrier could therefore be found, since the total charge and the number of carriers was known. The charge on each of the oxygen carriers was thus found to be about 310^{-10} electrostatic units.—Experiments were also carried out to find the size of the carrier on which the charge resides when the water has been evaporated from the drop by drying the gas. The body which is left is too small to move appreciably under the force of gravity, so that its size was obtained by finding the velocity with which it moved through the gas when acted on by an electromotive force. Thus in the case of the oxygen from the sulphuric-acid electrolyte, the radius of the drop in the cloud when the gas is saturated with moisture is $6{\cdot}815^{-5}$ centimetres, and when the gas is dry the size is reduced to $1{\cdot}110^{-6}$ centimetres. That the carriers on which the charge resides, when the gas is dry, are large compared with molecules, was also proved by showing that they diffused very much slower than a gas. A series of experiments made with the hydrogen and chlorine which are given off when a current is sent through a hydrochloric-acid electrolyte, showed that in this case the hydrogen carries a positive charge and the chlorine a negative charge. It was found that the charge on the hydrogen did not remain constant when carbon electrodes were used, but that, when the chlorine had dissolved in the acid and surrounded the negative electrode, the charge on the hydrogen became negative. This effect does not take place when platinum terminals are used, the charge on the hydrogen remaining always positive. AUTHOR.

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507. *Spark Discharge.* **R. Swyngedauw.** (Écl. Électr. 14. pp. 326–335, 1898.)—This paper forms a detailed reply to the criticisms of Jaumann on the author's researches. The main point at issue is as to whether the statical sparking potential between two knobs is the same as the sparking potential corresponding to rapid variations of the charges. This question is answered in the affirmative by the author, and is negatived by Jaumann. The latter has described experiments which at first sight appear to support his conclusion, but which the author shows may be interpreted so as to be in agreement with his own theory. Then follows a detailed examination of some of Jaumann's experiments: he has asserted that the process of charging by means of an influence-machine cannot be regarded as statical or gradual, on account of the oscillations which take place in the charges. The author has carried out a large number of experiments, using the following three methods:—(1) Connecting the knobs of the discharger to the plates of a plane charged condenser, and then slowly increasing the distance between the plates until sparking between the knobs takes place. (2) The knobs being maintained

at a constant P.D., the distance between them is gradually reduced until sparking occurs. (3) The knobs are connected to the coatings of a large leyden, which is then slowly charged by an influence-machine. Using knobs of different diameters and with different sparking-distances, the author finds very close agreement between the results furnished by the three methods. Jaumann's results, on the other hand, exhibit wide divergences. The author is of opinion that the discrepancy between his own results and those of Jaumann, is mainly due to the fact that the latter had his electrodes placed in a closed vessel. The author had himself tried this plan, but found, contrary to his expectation, that it was impossible to obtain consistent results unless the air surrounding the knobs were violently agitated. He supposes that, on account of the comparative immobility of the air modified by the passage of the spark, the sparking potential with enclosed knobs is altered. Hence the arrangement is one to be avoided. All the author's later experiments, which give perfectly consistent results, were carried out in free space.—There is only one exception to the general rule that the sparking potential is the same whether gradually or suddenly applied, viz., when the discharger is exposed to ultra-violet radiation. In this latter case, the lowering of the sparking potential is a steadily-increasing function of the rate of variation of the P.D. between the knobs of the discharger. A. H.

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508. *Spectrum of Kathode Rays.* **Birkeland.** (Comptes Rendus, 126. pp. 228–231, 1898.)—This is a reference to a note by the author in the Comptus Rendus for Sept. 28, 1897, that magnetically-deviated kathode rays are dispersed into a spectrum-like bundle, and to Thomson in Phil. Mag. for Oct. 1897. The appearances of these spectra vary when the kathodes are changed, and vary more with the construction than with the material of the kathodes; but with precautions described, uniform results may be obtained. The spectrum is then obviously a line-spectrum; but these lines are found to widen apart more or less when the capacity and the resistance of the circuit are increased. The author concludes that the kathode emits (1) intermittent discharges regulated by conditions exterior to the tube (difference of potential between the anode and the kathode, capacities and conductivities in the neighbourhood of the kathode), these discharges giving rise to the kathode rays; and (2) similar discharges regulated by the conditions within the tube, which discharges give rise to the phenomena of stratification. A. D.

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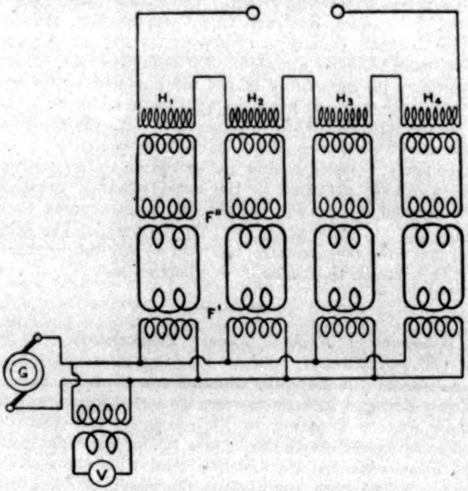
509. *Discharge at* 150,000 *Volts.* **C. P. Steinmetz.** (Elect. World, 31. pp. 294–295, 1898.)—This is an investigation of the phenomena taking place during a disruptive discharge at very high voltage in a circuit of sufficient power to maintain an arc. A series of photographs are taken differing from each other in

length of exposure. As discharge-terminals there are used two half-inch brass spheres, separated from each other by 14 inches, and in some cases by 15 inches. The camera was focused on the discharge-terminals and the cap taken off the lens; the generator-switch was closed to start the disruptive discharge, and the generator-field switch was opened after the discharge had lasted the desired time.

The high voltage was obtained by means of a series of transformers arranged as in the accompanying diagram.



From a series of twelve interesting photographs, the author draws the following conclusions:—

(1) The discharge of a high-potential circuit is always oscillating, even if sufficient power is behind the circuit to maintain an arc; and a number of successive oscillations are necessary to weaken the disruptive strength of air sufficiently to maintain an arc. Thus the dielectric strength of air is not reduced to zero by a single electrostatic discharge or rupture, but, on the contrary, is still sufficiently high to force the next oscillation into a somewhat different path.

(2) An arc impelled by extremely high voltage, and with considerable power behind, is in continuous and very rapid eddying motion, flaring upward, due to the upward draught of heated air. It never extinguishes itself, but frequently appears to jump across space by what seems to be bifurcation. W. G. R.

510. *Kathode Rays in an Alternating Field.* **H. Ebert.** (Annal. Phys. Chem. 64. 2. pp. 240-261, 1898.)—Schmidt's interesting experiments on the deflection of kathode rays in obedience to the impulses of a changing electrostatic field were repeated by the author in a manner such as to make the kathode-ray circuit quite independent of the alternating circuit. The author used a high-frequency alternator transformed to 1500 volts effective voltage by means of a Siemens spark-inductor. The secondary current was communicated to a small plate-condenser embracing a Braun phosphorescence-tube just behind the diaphragm. The deflections of the line of light on the screen were studied by means of a rotating mirror. They were perfectly sinusoidal. These deflections were not in this case due to a displacement of the origin of the rays on the kathode, since that origin was 30 cm. off behind a metallic diaphragm. Moreover, on removing the condenser-plates a few cm. from the tube, the deflections ceased. They could be restored by substituting glass or ebonite for the air between the plates and the tube. The deflections are not due to the magnetic forces of the electric displacement currents, but they are strongly influenced by the charges on the tube-walls. Their cause must be sought for in the bending experienced by the kathode rays on coming into contact with the dark spaces created by the electric oscillations inside the tube. E. E. F.

511. *Action of Magnetic Force on Vacuum Discharge.* **Birkeland.** (Comptes Rendus, 126. pp. 586–589, 1898.)—The author placed a cylindrical Crookes tube coaxially with a straight cylindrical electromagnet, and investigated the influence of magnetic force on the discharge, by slowly moving the tube nearer to the magnet. He found the effect extremely small until the tube reached a certain critical distance, at which the whole nature of the discharge suddenly changed. The difference of potential between the anode and kathode fell to below one-tenth of its original value, and the kathode rays were replaced by others which did not produce phosphorescence on the glass but manifested themselves by a glimmer along the lines of magnetic force. It is found that the magnetic force at the kathode is the chief factor which influences this sudden change, but the time that the discharge has been passing also influences it a little. A curve having for abscissæ the magnetic force at the kathode, and for ordinates the potential of the kathode at the moment of the change (the anode being connected to earth), is approximately a straight line, and for different gases the lines roughly agree. When the magnet acts on the kathode, particles of the metal of the kathode are projected violently against the glass and form a mirror on the tube. The pressure of the gas simultaneously falls, the gas condensing on the glass; and the amount of gas which thus disappears, other things being equal, is proportional to the current in the primary of the coil causing the discharge.

J. B. H.

512. *Hertz Resonators.* **A. Turpain.** (Comptes Rendus, 126. pp. 418–420, 1898.)—A circular resonator presenting a gap works as well as if the resonator were complete. The difference between the half-wave-length in the complete resonator and in the resonator with a gap, of the same radius, is $\lambda - \lambda_c = 2c$, where c is the length of the gap. A. D.

513. *Frequency of Hertzian Oscillations.* **L. Décombe.** (Comptes Rendus, 126. pp. 518–521, 1898.)—A direct method of measurement is described, by photographing the spark in the resonator-gap by means of a mirror rotating 500 times a second. Oscillations more frequent than 5,000,000 per second have been successfully photographed on gelatino-bromide plates. For very rapid oscillations the angular velocity of the mirror must be great; and the spark is put in the focal plane of a collimating lens of considerable focal length, so that the rays emerge parallel from this lens and are then received by the rotating mirror, which is concave and of short focus. With this arrangement, by rendering the focal length of the mirror short enough, any desired brilliancy may be given to the image on the photographic plate. The number of oscillations in a single spark-discharge depends on the capacity of the jar: as many as 40 have been counted. This tends to confirm both Poincaré's and Bjerknes' view, according to which only oscillations of a single frequency are emitted. A. D.

514. *Secondary Waves in Dielectrics.* **A. Righi.** (Memorie della R. Acc. dell' Istituto di Bologna, 6. p. 189, 1898.)—A resonator of natural wave-length 20 cm. is placed near a vibrator composed of two spheres 3·75 cm. in diameter and provided with a parabolic mirror. A solid glass sphere 8 cm. in diameter is placed with its centre 20 cm. or more from the middle of the resonator. When the sphere changes its place, it is found by experiment that the periodic electric force which it produces at R (the resonator) is a maximum or a minimum under the same circumstances as those given by calculation, supposing it placed in a constant field. Analogous results are obtained with a solid cylinder or a prism. By using two spheres or two cylinders, interference of the secondary waves may be observed.

If between an oscillator O and a resonator R, which are crossed, is introduced a dielectric D, the shape of which is not one of revolution about OR, the sparking of the resonator may reappear; there are four positions of D for which the sparking is a maximum, and four for which it is null. This effect persists even if the plate D is covered by a metallic screen with a circular opening between D and R. G. B. M.

515. *Electricity and Dermatology.* **W. S. Hedley.** (Elect. Rev. N. Y. 32. p. 39, 1898.)—This is a short review of the application of electricity to the cure of various skin-diseases, and

suggestions as to the possible application of powerful static charges to rid the surface of the body of micro-organisms and other conditions upon which cutaneous disease may depend.

W. G. R.

516. *Death by Electricity.* **W. S. Hedley.** (Elect. Rev. 42. pp. 207–208, 1898.)—The author gives a summary of the views held on the actual causes of deaths by electricity. Among the conditions to be inquired into, the author emphasises the duration of contact. Small currents may kill when applied for 5 or 10 sec., and momentary, large currents, not fatal in single instances, likewise when repeated. The *post-mortem* generally shows apnœa, the left side of the heart being almost empty, the right side distended with dark, fluid blood; sometimes lesion of the nervous system, more frequently only slight hæmorrage in the fourth ventricle and in the meningeal coverings; mostly a burn on the spot where the current entered, not so frequently at the exit. Death seems to result from mechanical lesion (lightning), or from suspension of respiration or of the action of the heart or of nutritive exchanges. Death may begin at the heart, acting more upon the cardiac muscles (Tatum, L. Jones) than upon the nerves, or may be due to contraction of the arteries (Bleile) caused by affection of their nerves, or by constriction of the pulmonary arterioles consequent upon the deoxygenation of the blood. As regards the treatment, D'Arsonval's rule to proceed as in cases of drowning still holds good: artificial respiration should be commenced at once, and be long continued. Amyl nitrite may be beneficial, as it paralyses the walls of the small blood-vessels and counteracts constriction.

H. B.

517. *High-Tension Test for Dielectrics.* **C. E. Skinner.** (Elect. World, 31. pp. 300–302, 1898.)—A testing-set for voltages from 1200 to 100,000 is described, and the switching and regulating arrangements are illustrated. The current is supplied from a 30-kw. transformer that has its secondary divided into four equal sections. The primary is provided with resistance-loops brought out to a regulating dial; by this means, the current may be varied in steps of 1 per cent. of the maximum. A second transformer, with secondary wound to one-tenth of the first, is used for lower voltages. Both transformers are operated from the same regulator and primary switching-apparatus; the change is effected by a throw-over switch. The current goes to line through two plug-switches of the blow-out type; the circuit is made or broken through a mercury switch. With the exception of the final two terminals, the whole of the high-tension circuit is immersed in oil. The measuring instruments are direct-reading; they are of the Thomson inclined-coil type, with one terminal connected to the containing case to diminish static effects. The ammeter is used with an auto-transformer, so as to be capable of giving

a full-scale reading from one-sixteenth to sixteen times its normal range. This apparatus is well adapted to the investigation of high-tension discharges. A curve is given, showing the striking-distance between needle-points in air, from 0 to 200,000 volts, at 16,000 alternations. R. A.

518. *Insulation Resistance (measured by Voltmeter).* **S. A. Russell.** (Elect. Rev. 42. pp. 251–254, 1898.)—The author describes the measurement by a voltmeter of the insulation resistance of a two-wire and three-wire system of mains. In the case of a two-wire system, the insulation of each main separately is deduced from three voltmeter-readings—one between the mains and one from each main to earth. In the case of a three-wire system, only the combined insulation resistance of the three mains to earth can be measured, though formulæ are given for finding a minimum value of the insulation of each main. By taking a double set of readings, however, varying the ratios between the voltages on the two sides, the three insulation resistances may be separately determined, though by somewhat complex formulæ. To obtain good results, the voltmeter-resistance should be comparable with that of the insulation; but the author recommends an electrostatic or high-resistance voltmeter, provided with two or three shunts. G. H. BA.

519. *Measurement of Low-Resistance Standards.* **W. M. Stine.** (Elect. World, 31. pp. 272–273, 1898.)—The author describes a modification of the Carey-Foster bridge for the accurate measurement of very low resistances, for use as standards. If P and Q be the reversible resistances of the bridge, P is a standard ohm; Q is made exactly equal to P by shunting Q with a high resistance, or by adding resistance in series with Q, as may be necessary. The low-resistance standard R is substituted for the slide-wire of the bridge, and the galvanometer-lead connected with one of its terminals (that nearest to Q); the resistance R is short-circuited with a heavy copper bar, and balance obtained under these conditions by adjusting the resistance of the connections. The short-circuiting bar is removed, and P is shunted with a high resistance S, so as to again obtain balance. The resistance of the standard R is then given by the formula

$$R = P - \frac{P \times S}{P + S}.$$

For a high degree of accuracy the galvanometer must be very sensitive and of low resistance, the connections heavy, and the apparatus protected from thermal effects by means of a cover. The author refers to a similar arrangement proposed by E. Willyoung (see Science Abstracts, No. 149, Feb. 1898.) A. H. A.

520. *Kelvin Electrometer as Wattmeter and Voltmeter.* **E. Wilson.** (Elect. Rev. 42. pp. 308–309, 1898.)—The first section of the paper deals with the experimental verification of Maxwell's formula. In the Phil. Mag. for April 1885, Dr. J. Hopkinson had shown that the sensibility of the older type of electrometer increased with the charge on the needle up to a certain point, and beyond that diminished. This peculiarity was ascribed by Ayrton and Perry to the action of that portion of the guard-tube in the immediate neighbourhood of the needle. In the experiments described by the author two electrometers, numbered 71 and 184, were used. No. 184 was of more recent construction, with the portion of the guard-tube immediately surrounding the needle omitted. The author found that with a constant pressure between the quadrants of this latter type of instrument the deflection steadily increased up to the point of disruptive discharge, thus proving the correctness of Ayrton and Perry's hypothesis. Experiment also showed that Maxwell's formula held good, the greatest divergences observed amounting to 1·5 per cent.; these were within the limits of experimental error. Electrometer No. 184 was next connected up as a wattmeter, the case and needle being connected between the two points where the power was to be measured, and the quadrants being joined across a non-inductive resistance included in the main circuit. By taking curves of instantaneous pressure and current the mean value of the product of these two quantities could be determined, and so the relation connecting the electrometer deflection with the power obtained. A. H.

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521. *McWhirter's Shielded Measuring Instruments.* (Elect. Engin. 21. pp. 330–331, 1898.)—These instruments are of the electromagnetic type, their novel feature being a shield to prevent disturbance from stray fields. The shield is a case of iron ¼ in. thick covering the coil and forming part of its magnetic circuit. Tests by Jamieson show that the shielding is excellent, the temperature error only ¼ per cent., and the error due to residual magnetism no greater than in the ordinary type. G. H. Ba.

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522. *Interrupter for Induction-coils.* **V. Crémieu.** (Comptes Rendus, 126. pp. 523–526, 1898.)—A construction is described in which "make" and "break" are equalised by commutating so as to replace each by the sum of a make and a break, this being followed by a similar make and break in the opposite direction, and so on alternatingly. The equalisation is very effective; but the E.M.F. required is double that needed by a Foucault interrupter. The apparatus is reversible, so that an alternating current supplied to one coil produces a redressed fluctuating current in the other, with equidistant instants at which the current-strength is zero. Advantage is taken of this last circumstance, by an ingenious mechanism, to prevent sparking. A. D.

523. *Phasemeter.* **J. Tuma.** (Wien. Akad. Sitzber. 106. pp. 521–525, 1897.)—For a description of the author's earlier instrument see Abstract No. 290. The present paper contains an account of an improved form of the instrument. It consists essentially of two pairs of mutually perpendicular coils, one of which is fixed, the other movable. The fixed pair of coils is wound on slit spherical brass bobbins, the field due to each coil being thereby rendered very uniform. The movable system consists of two smaller mutually perpendicular cylindrical coils wound on paper frames and placed inside the fixed coils; the system is suspended by a silk fibre, and a pointer attached to the spindle supporting the movable coils indicates their position on a horizontal scale. Each of the two alternating currents, the phase-difference between which it is desired to determine, is made on entering the instrument to divide into two equal parts having a phase-difference of very nearly 90°. This is accomplished by connecting one of each pair of coils in series with a non-inductive resistance, and the other with a high inductance. Thus each alternating current is made to produce a rotating field. The connections are such that the two fields rotate in the same direction. Now the angle between the fields is the required angle of phase-difference. It is obvious that the movable system of coils will take up a position corresponding to coincidence of the two rotating fields. The angle between the fixed and movable systems of coils is then the angle of phase-difference. A. H.

524. *Graphical Methods in Alternate-Current Problems.* **C. E. Guye.** (Écl. Électr. 14. pp. 321–325, 1898.)—This is the first instalment of a paper on the above subject. After a brief historical introduction the author considers the fundamental assumptions which underlie the graphical method, and which frequently limit its range of application. These assumptions are:—(1) The variable quantities dealt with are simple sine functions of the time (if this condition is not fulfilled in practice, an *equivalent* sine function may be considered). (2) The *steady* state only is considered—no account being taken of abnormal initial phenomena such as occur when an alternating E.M.F. is suddenly introduced into an inductive circuit. (3) Where capacities are considered they are always supposed to be *constant* and *localised*; the complex phenomena arising in cases of distributed capacity not being dealt with. (4) The method is applicable to relatively *slow* alternations only, for which the resistance may be supposed constant. (5) Self and mutual inductances are supposed constant. The author then considers the representation of a simple periodic function by means of an alternating vector, and points out the desirability of uniformity in notation. A. H.

525. *Electric Osmosis.* **G. G. de Villemontée.** (Écl. Électr. 13. pp. 49–59, 106–111, 168–176, 208–217, 313–321, 395–403, and 497–507, 1897.)—The author gives a detailed

historical and critical account of electric osmosis and migration. The papers touch on the work of Becquerel, Daniell, and Miller, Pouillet, Hittorf, Almeida, Napier, G. Wiedemann, Quincke, Tereschin, Helmholtz, Lamb, and others. W. R. C.

526. *Acoustic Properties of the Arc Light.* **H. T. Simon.** (Annal. Phys. Chem. 64. 2. pp. 233–239, 1898.)—The flame of an arc-lamp is very sensitive to slight variations of the current, such as those produced by induction from a neighbouring intermittent current. When the neighbouring circuit contains a microphone, the arc may be made to reproduce various sounds and noises communicated to the latter. It reproduces them with great fidelity. Conversely, a sound impinging upon the arc produces in it changes of density, which give rise to changes of resistance and modifications of the current, which may in turn excite a telephone. The arc thus plays the part of a telephone receiver and transmitter.

E. E. F.

527. *Magnetic Properties of almost Pure Iron.* **E. Wilson.** (Elect. Rev. 42. pp. 313–314, 1898.)—The iron studied contained traces of carbon and silicon, no phosphorus, 0·013 p. c. of sulphur, and 0·1 p. c. of manganese. Some of the results obtained with an *annealed* ring, having an internal diameter of 3·2 cm., an external diameter of 4·5 cm., and a depth of 2·6 cm., are given in the following table:—

Limits of H.	Limits of B.	$\frac{1}{4\pi}\int H dB$.	μ.	Coercive force in C.G.S. units.
0·783	1,965	262	2,510	0·50
1·14	4,840	......	4,245	
1·17	5,150	1080	4,400	0·73
1·42	7,500	......	5,280	
1·66	9,100	2490	5,480	0·90
2·23	11,460	......	5,140	
2·68	12,500	......	4,660	
4·74	14,270	......	3,010	
9·24	15,270	......	1,650	1·13

The author points out that an induction-density of 15,270 for $H=9\cdot24$ is higher than he remembers having seen. Very noteworthy is the apparent *magnetic instability* of the iron under certain conditions. It is well shown by the following experiment. The magnetic force was changed from its maximum value through zero to the value of the coercive force, and the secondary circuit closed at known intervals of time *after* such change. The results are given in the table below.

Time in seconds	0.	1.	2.	3.	4.	5.	6.	10.
Change in B, 10 cells exciting through extra resistance	13,600	4,030	1,990	927	576	285	175	42
Change in B, 56 cells exciting through extra resistance	13,800	3,690	1,680	944	529	256	...	40

The object in using two different batteries is to prove that the time-constant of the circuit has nothing to do with the phenomenon. The figures show that 30 per cent. of the induction comes out after the first second has elapsed. With a total reversal from one maximum to the other no such effect was observed, the change taking place immediately. The author makes some calculations which show that the above results may be partly due to induced currents in the iron, but that they are principally due to a genuine magnetic instability. A. Gs.

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528. *Physical and Chemical Modifications by Magnetism.* **D. Hurmuzescu.** (Écl. Électr. 13. pp. 357–362, 1897, and 14. pp. 279–284, 1898.)—The author has examined the variations, due to magnetism, of various quantities. In order to see if magnetism causes a change in volume, a solution of ferrous sulphate was made use of in a dilatometer. A contraction always takes place, which fact is not in harmony with Poisson's theory of magnetism. The specific resistance of iron increases when placed in a magnetic field, the value of $\frac{\Delta R}{R}$ being of the order 0·002. Copper is unaffected, and only a negative result was obtained with a solution of ferrous sulphate. Experiments are also described showing how chemical action is influenced by the lines of force in a magnetised iron plate, and how electrolytic deposits are affected (see Abstract No. 531). W. R. C.

ELECTRO-CHEMISTRY AND CHEMICAL PHYSICS.

529. *Explosive Properties of Acetylene.* **Berthelot** and **Vieille.** (Annal. Chim. Phys. 13. pp. 5–29, 1898).—The memoir is in three sections:—

I. In the first section solutions of acetylene and their explosive properties are considered. It has been recently found that dissolving in acetone diminishes the danger of the use of acetylene in lighting. Tables of the tensions of the solution at various temperatures are given; they conform generally to Regnault's law for saturated vapours. As to the explosibility of the preparation, an iron bottle enclosing 320 c.c. of the solution of 41·25 per cent. strength was furnished with a submerged tube containing 1·5 grm. of fulminate; the detonation of the latter did not affect the acetylene. On the other hand, a solution of 64 per cent. at a pressure of 20 kilos at 13° C. undergoes explosion by simple inflammation. Steel tubes partially filled were fitted with a platinum wire immersed partly in the liquid and partly in the vapour; on raising the wire to incandescence the vapour always exploded, the liquid sometimes, but the pressures generated were only about one tenth of those which would have been caused by the gas alone. When, however, the liquid is saturated at pressures above 10 kilos per sq. cm., the result approximates to that with pure liquid acetylene, the acetone being completely decomposed at the same time, yielding H, CO, CO_2 and a compact mass of carbon. Experiments on a larger scale proved that the vessels commercially used for acetylene (tested at 250 atmospheres) could support without rupture an explosion of the gaseous atmosphere surmounting a solution in acetone, saturated under 6 to 8 kilos per sq. cm. at 10° to 15° C. At higher pressures no industrial recipient could withstand the explosion, a result which might occur accidentally through a rise of temperature. For example, a solution saturated at 14° C. under 6·74 kilos, would, if the temperature rose to 35°·7 C., which might easily occur by the heat of the sun or of a fireplace, exert a pressure of 10·55 kilos. As to the advantage of the solution, while a litre vessel of gaseous acetylene containing 2·5 grms. of the gas, corresponding to a pressure of 2 atm. at 0°, would be liable to explosion, a solution in acetone containing 100 to 120 grms. of acetylene would not explode at 15° if the pressure did not exceed 10 atm.

II. In the second section the authors deal with the decomposition of the solvent (acetone) in its physical relations. They point out that the complete dissociation of acetone requires a greater number of calories than can be furnished by the amount of the endothermic acetylene present in the ordinary solutions, which is the reason why the latter are not explosive when kept within the limits mentioned in the first section.

III. In the third section the authors further examine the conditions of explosibility when acetylene in large and in small steel vessels is subjected to an incandescent wire, or to a fulminate detonator under known initial pressures. The results in the case of flasks show that although it is impossible to fix a definite critical pressure below which the propagation of explosion cannot occur, yet that below an excess pressure of 520 mm. of mercury for an incandescent point, or 170 mm. for a detonator, there is no probable danger. The capacity of the recipient does not seem to make any appreciable difference. It is singular that in steel tubes, although there was some liberation of carbon, no propagation of explosion occurred. S. G. R.

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530. *Ionisation in Mixed Salt Solutions.* **A. Fock.** (Zeitschr. Phys. Chem. 25. pp. 74–78, 1898.)—If c and x are the concentrations in a liquid and solid phase in equilibrium, and γ and g the ionisations, then must $\frac{c(1-\gamma)}{x(1-g)}=$constant and $c\gamma/xg=$constant. Also, by the law of mass action $c(1-\gamma)/x^2g^2=$constant, and $c^2\gamma^2/x(1-g)=$constant, which also follows from the ionisation-isotherms in the two phases $c(1-\gamma)=k$, $c^2\gamma^2$ and $x(1-g)=k_2x^2g^2$. If the ionisation in the solid phase is set $=0$, we have $c(1-\gamma)/x=$constant and $c^2\gamma^2/x=$constant. In solutions of mixed salts of similar type the ionisation of each salt is generally supposed to be alike and unaltered by mixture, and therefore $=\gamma$ ionisation of the mixture, whence the last two equations should hold. This is not the case, but their sum remains constant $(c(1-\gamma)/x+c^2\gamma^2/x)$. The hypothesis of the constancy of γ is absurd, since we have then c/x and c^2/x or $c/\sqrt{x}$ both constant, which is impossible. Hence we must assume that γ varies, causing one expression to increase while the other decreases. The author assumes values of γ which make $c(1-\gamma)/x=$constant for mixed solutions of KCl and NH_4Cl, and finds the value of $c\gamma/\sqrt{x}$ remains practically constant. The dissociation in a mixture of equal molecules KCl and NH_4Cl being taken as that calculated for the mixture (5·5 normal) at 0·19, he finds the dissociation of NH_4Cl rise to 0·37, when the concentration c is lowered to 0·4, and the percentage NH_4Cl in the mixed crystals (from 10 °/₀) to 1·2 °/₀. B. B. T.

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531. *Electrolysis of Magnetic Salts.* (Elect. Rev. 42. pp. 322–323, 1898.)—This is an account of some experiments by Hurmuzescu on the behaviour of iron in electrolytic cells placed in strong magnetic fields. Two principal observations are made: one, that the rate of deposition and dissolution of iron electrodes is greatly affected by the magnetisation of the iron; the other, that electrolytes containing magnetic salts, placed in a magnetic field, show vortical movements, or eddies, when a current of electricity is passed through them. In one of these experiments an electrolytic cell, containing a ferrous electrolyte, is divided in the

middle by the two iron poles of a powerful magnet. The opposed edges are sharp and near to one another so as to obtain great concentration in the field-strength. When a current flows it is found that the deposition of iron is greatest on the highly magnetised edges. In a second experiment, between the two magnetised edges a small plate of iron is placed. Eddies then occur in the solution on each side when a current is passed. Some remarks on the regular way in which an iron-wire anode or iron-plate anode is eaten away, lead to the practical application of electrolysis in sharpening needles and knives. When a bundle of parallel wires is treated they become hexagonal in section, and do not remain circular. S. S.

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532. *Equilibrium in Solutions of two Salts with one Ion in common.* **C. Hoitsema.** (Zeitschr. Phys. Chem. 24. pp. 577–607, 1897.)—The author extends the theoretical conclusions of Nernst and Noyes to include the change in ionisation of the added salt, and obtains the following four equations:

$$xy=A^2d_1^2,$$
$$(a-z)/zy=k_2=a(1-d_2)/a^2d_2^2,$$
$$x+z=y,$$
$$x+A(1-d_1)=\text{Total solubility of salt XY};$$

where A is max. solubility of XY (sat. sol.), a is quantity of salt ZY added, d_1 and d_2 are the ionisations of these salts in the concentrations given, x, y, and z the concentrations of the ions. The latter three unknowns can be determined from three equations, and must satisfy the fourth. Excepting the case where addition of ZY does not increase y, the solubility of XY must always diminish, but eventually approaches a minimum. When the saturation point for ZY is reached the solution has a constant composition: this is the point where the same composition is attained by adding XY to a saturated solution of ZY, and may occur anywhere on the curve. Here we have the equations

$$xy=A^2d_1^2, \qquad zy=a^2d_2^2, \qquad x+z=y.$$

Where a double salt XZY_2 is formed, dissociating only into XY and ZY (mixed crystals excluded), we have

$$xy=A^2d_1^2,$$
$$p/zy=k_2,$$
$$x+z=y,$$
$$q+p+z=a,$$
$$x+A(1-d_1)+q=\text{Total solubility of XY};$$

where p and q are the concentrations of the undissociated ZY and XZY_2 salts. A sixth equation $q/pA(1-d_1)=k_3$ must be satisfied, by solution of the other five. Here the solubility of XY is first diminished and then increased; interrupted at any point as before, by the saturation of the solution with ZY or XZY_2.

In the first case, the composition becomes constant; in the second, the composition remains constant while the solid XY is converted into solid XZY_2; when the former is exhausted, the amount of dissolved XY falls on addition of ZY until the solution is saturated with the latter. The conditions in the latter part of the curve are

$$r/xy=k_1, \qquad p/zy=k_2,$$
$$pr=\text{constant}=q\ \text{max.}/k_3, \qquad x+z=y,$$
$$p+z+q\ \text{max.}=a, \qquad x+r+q\ \text{max.}=\text{Total solubility of XY},$$

where a is the amount of ZY added.

[In original "konst." is written manifestly by a slip in the last two equations; read "bestimmbar."—B. B. T.]

Where a complex salt $X(ZY_2)$ is formed, dissociating only into X and ZY_2, we have

$$xy=A^2d_1^2, \qquad x=y+w,$$
$$q+w=a, \qquad x+A(1-d_1)+q=\text{Total solubility of XY};$$

where w is the concentration of the ZY_2 ions. The fifth equation $q/xw=k_4$ must also be satisfied. Here addition of ZY increases the solubility XY until saturation with $X(ZY_2)$ causes the composition to remain constant until the solid XY is exhausted. The concentration of XY then falls according to the equations

$$r/xy=A(1-d_1)/A^2d_1^2, \qquad q\ \text{max.}/xw=k_4,$$
$$x=y+w, \qquad a=q\ \text{max.}+w,$$
$$r+x+q\ \text{max.}=\text{Total solubility of X}.$$

When all XY is removed from solution the concentration of X still falls according to the changed conditions

$$q\ \text{max.}/xw=k_4, \qquad s/zw=k_5,$$
$$x+z=w, \qquad a=q\ \text{max.}+w+s+z,$$
$$x+q\ \text{max.}=\text{Total solubility of X};$$

where s is the concentration of the $Z(ZY_2)$ salt which appears in solution simultaneously with the vanishing of the Y ions (*i. e.*, of XY). In this stage we have only $X(ZY_2)$, $Z(ZY_2)$, and the three ions X, Z, and ZY_2. The composition becomes constant when $Z(ZY_2)$ separates in the solid state.

The reverse procedure leads to the curious result that the smallest addition of XY to a solution of ZY must convert the whole of the latter into $Z(ZY_2)$, by formation of $X(ZY_2)$ and double decomposition of the latter with excess of ZY. A sudden change in the solubility of ZY should be observed; if this is not the case we must conclude that ZY does not exist, $Z(ZY_2)$ being the original salt. From this point the solubility of $Z(ZY_2)$ increases according to the equations

$$s\ \text{max.}/zw=k_5, \qquad q/xw=k_4,$$
$$x+z=w, \qquad a=q+w+s\ \text{max.}+z,$$
$$x+q=\text{Total solubility of Z}.$$

In the case of mixed crystals, the author rejects Nernst's conclusions, inasmuch as the partition-coefficients of ions and molecules, with the equilibrium constants of ions and molecules in each phase, produce more conditions than can be simultaneously fulfilled, whether or no we assume an excess of positive ions in one phase and negative in the other.

Applying the same principles as above, the author concludes that the curves of solubility will exhibit similar forms to the foregoing, with sharp angles and points of constant composition where double salts separate out, or where the mixed crystals are converted into double salts, but otherwise with a smooth continuous course from axis to axis with or without maxima and minima. B. B. T.

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533. *Chemical Action of the Silent Discharge.* **Berthelot.** (Comptes Rendus, 126. pp. 561–575 & pp. 609–630, 1898.)—These lengthy papers, constituting a continuation of the researches of about forty years, already partially published in the 'Essai de Mécanique Chimique,' vol. ii. pp. 362–400, scarcely admit of abstraction within reasonable limits, and therefore only a general outline can be attempted. Among their results have been the discovery of the total synthesis of acetylene, of hydrocyanic acid, of persulphuric acid and its congeners, and of the continuous fixation of free nitrogen by plants under the influence of atmospheric electricity. Special attention has been given to the *limit of transformation* under defined conditions of time and intensity.

The apparatus generally consisted of a Ruhmkorff's coil and Leyden jar with a Marcel-Deprez break, giving several hundred alternate discharges per second, worked by five accumulators for a period of 24 hours, the sparks of the coil and jar being 12 to 15 mm. long. Examinations were made after 24 hours, and also at intermediate stages.

The substances occupied the annular space between two glass tubes one mm. apart; discs and metallic leaves were also employed. The liquids were weighed in small bulbs, which were then broken in the upper part of the annular space, the tension of the vapour being observed. In the case of liquids with little or no vapour-tension, such as fatty oils, their collection at the bottom of the tubes, out of reach of the current, precluded exact results; the same interference of purely physical conditions occurred between gases and solids. With solutions, there was the difficulty of imperfect contact between liquid and gas, besides the secondary action on the solvents.

The changes almost invariably pass through a succession of phases, under the lateral influence of the compounds formed, till a final equilibrium is established. As examples, organic substances deficient in oxygen produce at first a little acetylene, which subsequently disappears by condensation; methane and nitrogen give at first ammonia, to be later destroyed; carbon monoxide and carbon dioxide yield highly oxygenated compounds, afterwards decomposed. The changes of volume are often very great—*e. g.* aldehyde with 14 c.c. of nitrogen gave in a few hours 64 c.c. of gas containing 11·5 c.c. methane, 7·3 c.c. hydrogen, 15·2 c.c. carbon monoxide, 11·5 c.c. carbon dioxide, 5·1 c.c. aldehyde-vapour, and 13·4 c.c. nitrogen. After 24 hours, 8·6 c.c. of gas, of which 7·3 c.c. was hydrogen and 1·3 c.c. nitrogen. In other cases, such as propylene, liquid polymers are first produced, and hydrogen is disengaged afterwards. The rapidity and even the nature of the reactions being functions of the intensity of discharge, it is essential to avoid internal brushes or sparks.

The final products are "solid or resinous" bodies of feeble conductivity with condensed and stable molecules, hydrogen, if in large quantity, remaining partially free, as in many similar inorganic actions. Compounds rich in oxygen furnish at first carbon monoxide, carbon dioxide, and water, with subsequent side-changes. Azotised bodies may first develop compounds containing more nitrogen, which may afterwards suffer decomposition with production of the free gas—the first fixation being in the form of amide or amine, and never in that of a nitric, nitrous, cyanogen or hydrazine derivative.

In every instance the initial action is a decomposition into hydrogen and simple binary compounds, with subsequent condensation into more complex molecules. The author draws a parallel between this and nutrition.

Details follow of experiments with gaseous mixtures under 24 hours of silent discharge. CH_4 and C_2H_6 gave about an equal volume of hydrogen; C_2H_4 at first formed a liquid, then about $\frac{1}{4}$ vol. of hydrogen: the condensation-product in each case being a hydrocarbon, $C_{10}H_{18}$, allied to the terpenes. With nitrogen they gave a "tetramine," $C_8H_{12}N_4$, solid, alkaline, and probably a polymer of acetylenamine. Acetylene condensed very rapidly to liquids, then to explosive solids oxidising very quickly in air. With nitrogen it gave $C_{18}H_{18}N_2$ or $C_{16}H_{16}N_2$, like the benzene-product. Propylene, trimethylene, and allylene behaved somewhat similarly. The synthetic azotised products constitute a new group of great interest.

Carbonic oxide, as Brodie and the author have shown, is broken up according to the equation

$$5CO = C_4O_3 + CO_2.$$

The suboxide C_4O_3 is a brown solid, soluble in water and of acid reaction. No combination between CO and N was occasioned in 12 hours.

Carbonic oxide with excess of hydrogen ($100CO + 244H_2$).—In 24 hours all the CO and about the same volume of H had disappeared, without production of CO_2 or C_2H_2; the condensed product consisted of a mixture of polymers of methyl aldehyde, CH_2O, some soluble, others insoluble in water. The former reduced nitrate of silver slightly, but not Fehling's solution, and blackened with burnt-sugar odour on heating.

Excess of CO ($100CO+50H_2$).—Results: 23 of residual CO, no H, no CO_2. Condensed product $C_3H_4O_3$, which may be either pyruvic acid, or $2CH_2O + CO$, or an oxidised carbohydrate, $C_6H_8O_4+O_2$, comparable to oxycellulose. It is similar to the product above, but has more reducing action.

Carbonic oxide, hydrogen and nitrogen.—Result in 24 hours: no hydrocarbon, CO_2, CO, nor NH_3. Condensed body corresponded to formamide, $HCO.NH_2$, or to $(CHN)_n, mH_2O+(n-m)H_2O$, a derivative of the first product $(CH_2O)_n$.—With a smaller proportion of CO the product had the composition $C_5H_4N_4O, 4H_2O$, which is that of sarcine. The smallness of the quantity precluded separation.

Carbon dioxide alone gives percarbonic acid, CO, and the suboxide described above. With hydrogen the CO_2 disappears, and there are found a few drops of an aqueous syrup, CH_4O_2 or $(CH_2O)_n+nH_2O$, smelling of acetic acid, but otherwise like the product with CO. With hydrogen and nitrogen in excess, no CO_2 or CO remain, while ammonium nitrite is formed, along with an unstable substance of the empirical formula $CHO.NH_2$. With less H and N, the result approximates to $CONH_2, H_2O$. Therefore, with excess of hydrogen, the general equations are:—

$$\left.\begin{matrix} n(CO+H_2) \\ n(CO_2+2H_2) \end{matrix}\right\} = C_nH_{2n}O_n-mH_2O\,;$$

a synthesis analogous to some of those occurring in plants, and connected with their formation of the nucleus or residue CH_2O from CO_2 and H_2O by elimination of O. If the hydrogen is deficient, the products are more highly oxidised. The addition of nitrogen yields bodies rich in this element, of the general formula $(COH_3N)_n-mH_2O$, related to the polymers of hydrocyanic acid and to the uric or xanthine family—or, if the oxides are in excess, to that of the ureides. When water is formed at the same time, especially with CO_2, ammonium nitrite appears, which is a normal product of the fixation of N on the elements of water.

The succeeding portion of the memoir describes the action of the discharge on alcohols and ethereal derivatives in presence of N. As regards the alcohols, the first stage is marked by a liberation of hydrogen, which continues at a lessening rate to the end of the process. Afterwards N is absorbed in the ratio of one atom to two of H lost, resulting in condensed alkaline bodies resembling the amidines. The loss of H is one atom in the case of methylic, and two in that of ethylic and propylic alcohol, similar to the behaviour of CH_4 and C_2H_6. Allylic alcohol, like acetylene and allylene, loses no H, though it fixes N in the ratio of N_2 to 3 of C_3H_6O. Phenols, like their parent hydrocarbons, lose no H, but fix N in unequal proportions, the products being neutral. Ethers behave like their related alcohols. Except methylic, the alcohols fix about twice as much nitrogen as their parent hydrocarbons. Isomeric alcohols behave in the same way; isomeric phenols do not. S. G. R.

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534. *Electrolytic Estimation of Cadmium.* **D. L. Wallace** and **E. F. Smith.** (Chem. News, 77. pp. 93–94, 1898.)—Smith's experiments of 1878 having been doubted by Heidenreich and others, the authors have repeated them with definite units. Solutions of cadmium acetate or sulphate, not too acid, were precipitated at 50° C. by a current of 0·02 to 0·08 ampere for 37 sq. cm. kathode-surface, voltage 2·5 to 3·5, in 4 to 4½ hours, in a crystalline and firmly adherent form, with excellent quantitative results. Neumann has, moreover, succeeded in the process. Smith's method of separating copper from cadmium was also confirmed. In the presence of free HNO_3 (about 2 per cent.) copper is completely deposited, while all the cadmium remains in solution. S. G. R.

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535. *Taste of Acids.* **T. W. Richards.** (Chem. News, 77. pp. 91–93, 1898.)—The author is of opinion that the sourness of acids is probably to be referred to the hydrogen ion. The water used had been distilled in platinum from alkaline permanganate, and then redistilled, and was singularly tasteless. About 5 c.c. of the solutions, warmed to 40° C., was held on the tongue for a few seconds, "until a constant intensity of taste was secured." Beakers with 10 c.c. of water and 0·05, 0·10, 0·20, and 0·30 c.c. of decinormal HCl, and with unseen labels, were readily classified correctly by taste; 0·3, 0·4, 0·5, and 0·6 c.c. of the acid gave less accuracy, a mistake being made in the order of the last two. With H_2SO_4, HNO_3, and HBr, the sensitiveness was about the same, a strength of somewhat less than millinormal seeming the limit of detection. A liquid distinctly sour became tasteless on neutralisation; hence neither K nor Cl ions can possess so strong a taste as those of H. The order of decreasing sourness was found to be: mineral acids, tartaric, citric, acetic. The latter tasted as strong as HCl of $\frac{1}{3}$ its concentration, although Kohlrausch had found that at $\frac{1}{333}$ normal only about $\frac{1}{14}$ of the acid was dissociated (Wied. Ann. 26. p. 161, 1885). Small additions of KCl had no appreciable effect on the taste of very dilute HCl, whereas the sourness of acetic acid was noticeably diminished, and that of HCl almost destroyed, by small amounts of K or Na acetates, in accordance with the dissociation hypothesis and the mass law, "which tells us that in such a reaction as

$$CH_3COOH \leftrightarrows H + CH_3COO-$$

the addition of a large proportion of acetic ions from the almost wholly dissociated sodic acetate is capable of forcing the reaction backwards and destroying the hydrogen ions." This is analogous to the effect of salts in modifying the catalytic action of acids on cane-sugar and esters. An application of these principles occurs in the preparation of soda-water, whose sourness is rendered soft to taste by the addition of sodium bicarbonate.

The author then applied the sense of taste to ascertaining the end-point of an acidimetric determination, adding a slight excess of acid, and then alkali till the sourness just disappeared. The figures given indicate that surprising delicacy may be attained with practice. The tastes produced by small electric currents, and also the effect of sugars in mitigating undue sourness, were examined with as yet unsatisfactory results. S. G. R.

536. *Electrolysis of β-methylglycidic and β-methylglycerinic Acids.* **L. B. Pisarjewsky.** (Journ. Russ. Phys. Chem. Soc. 29. pp. 338–340, 1897; also Ecl. Élect. 14. pp. 443–444, 1898.)—On electrolysing the potassium salt of β-methylglycidic acid, oxidation takes place with formation of formic and acetic aldehydes and acids, and an unidentified substance which reduces Fehling's solution powerfully, and forms a gummy yellow barium salt: of these, formic aldehyde is the chief product. The gases evolved consist of 70–75 p. c. CO_2, 14–16 p. c. CO, 10–12 p. c. O_2, and 0·4–0·6 p. c. gas absorbed by H_2SO_4; the amount of CO and O_2 increases with the dilution. Potassium β-methylglycerinic acid gave the same products but in noticeably different proportions, less formic aldehyde, more acetic acid, and more CO (38 p. c.) and O_2 (19 p. c.). The latter may be due to the greater dilution employed. B. B. T.

537. *Guttapercha.* **E. Obach.** (Elect. Engin. 21. pp. 20–22, 51–53, 115–117, & 146–147, 1898.)—The earliest recorded specimen of guttapercha seems to have been brought to Europe by the Tradescants about 1560 and deposited in their museum. In 1843 it was rediscovered by Drs. D'Almeida and Montgomerie, and submitted by the latter to the Society of Arts, who reported favourably on its utility. In 1847 the tree was first named and figured by Sir W. J. Hooker; during the same year, Dr. Ernst von Siemens introduced the material as an insulator, and designed a machine for covering wire.

The original source of guttapercha, and still the origin of the best material, is a lofty tree native to Singapore and other Malay countries, and is called Jaban Merah in Perak and Niato balam tembaga (or abang) in Sumatra. It is from 60 to 150 ft. high and from 2 to 5 ft. in diameter. The gum is derived from the milky juice or latex, which is contained chiefly in the inner parts of the bark, also in the pith and leaves, but not in the wood. An elaborate description of the leaves, flowers, etc., with illustrations and photographs, was given in the lecture, from which it appears that although the leaves may vary in size and shape, the general botanical characters are very distinct. Sir W. Hooker's original name of *Isonandra gutta* has been superseded by that of *Dichopsis gutta* (Benth.) in England, or *Palaginium gutta* (Burck) on the Continent. The natural order is Sapotaceæ. The tree, which attains maturity in about 30 years, is very irregularly distributed in the islands, and is becoming scarcer.

Recent explorations in German New Guinea have discovered several species, *e. g.* Getah Susu, Maran, and Natu, closely allied to guttapercha, but the gums, according to the author, have no resemblance. Only one of them contains a small percentage of "caoutchouc-like substance or pseudo-gutta."

The destruction of the trees by the Malays having threatened the further supply, the French Government in 1881 sent an expedition to search for the trees and enquire into their possible cultivation. Seligman discovered a number of various kinds, including the true gutta, of which he forwarded young plants to Europe.

A second and English expedition was sent from Perak, in 1883. Leonard Wray collected plants and specimens from a number of caoutchouc and gutta-producing species, with the coagulated latex or "getah" from seven different trees, and obtained much information. He comments upon the wasteful manner in which the gum is collected by the natives, and suggests that the bark—which in the dry state contains over 11 °/o of guttapercha, and is now thrown away—should be utilised for extraction.

The physical properties of guttapercha are well known. The softening temperature varies, but never exceeds 66° C. By destructive distillation, *isoprene* C_5H_8, sp. gr. 0·682, B.P. 37° C., and *caoutchine* $C_{10}H_{16}$, sp. gr. 0·842, B.P. 171° C., and other hydrocarbons identical with those from caoutchouc, are obtained.

Tilden has succeeded in reconverting isoprene into caoutchouc by means of strong hydrochloric, or in the presence of acetic or formic acid, thereby suggesting a synthesis of the gums from the lower terpenes. Quite recently two Russian chemists have proved isoprene to be asymmetric methyldivinyl, $CH_2=C(CH_3)-CH=CH_2$.

Guttapercha is destroyed by strong nitric or sulphuric acid, but not by other acids nor by alkalies. Alcohol, ether, and many other solvents dissolve it partially, extracting mainly resinous bodies; in carbon disulphide, chloroform, and carbon tetrachloride it is completely soluble, leaving the impurities. S. G. R.

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538. *Ionisation in Aqueous Alcohol Solutions.* **E. Cohen.** (Zeitschr. Phys. Chem. 25. pp. 1–45, 1898.)—The conductivity at 18° C. of KI in absolute and aqueous alcohol in concentrations from V=64 (litres per gramme-mol. wt.) to 4096 is measured with great care, and $NaC_2H_3O_2$ in 50 °/o alcohol from V=64 to 1024, and measurements by others of KCl, NaCl, HCl, etc. are criticised and compared, with the following results:—

1. Replacement of alcohol by water in an alcoholic solution generally raises the conductivity; but with very weak solutions

($V=256$, or 512 and over) the solution in absolute alcohol may have a higher conductivity than the aqueous solution (99 °/o to 80 °/o).

2. In solutions in weak alcohol, the alcohol strength has the same influence on the conductivity for all concentrations, for all the various (strongly dissociated) salts investigated, and apparently for different temperatures. The conductivity of a dilute solution (lower limit of V about 64 for 40 °/o to 512 for 100 °/o alcohol) may be obtained from that of an aqueous solution of equal strength by multiplying by the [approximate] factors :—

10 °/o	20 °/o	30 °/o	40 °/o	50 °/o
0·73	0·57	0·47	0·40	0·35

This enables the limit of conductivity at infinite dilution for alcohol solutions to be calculated from aqueous solutions. It should follow from this that the ionisation is the same in alcohol (up to 60 °/o) as in water solutions at the same concentration; but the author prefers, on other grounds, to hold that the conductivity is no correct measure of the ionisation.

See also Walker & Hambly, J. Chem. Soc. 72. pp. 61–72, 1897.

B. B. T.

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539. *Avogadro's Law and the Liquid State of Aggregation.* **U. Dühring.** (Annal. Phys. Chem. 62. 1. pp. 204–205, 1897.)—A reclamation: J. Traube has stated that Avogadro's law for gases may be applied to liquids, if we consider only that part of their volume which is not occupied by the molecules themselves and their sphere of action. E. and U. Dühring have gone further, in 1886, in proving this extension of the law to hold both for liquids and solids. It is, however, necessary to consider equal heat pressures and not external pressures. For the pressure produced by the heat in the interior of a liquid is entirely different from the pressure observed on some boundary surface. The heat pressures of various liquids differ for equal temperatures and equal external pressures, as Dupré pointed out more than forty years ago. H. B.

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540. *Metallic Sulphide Electrodes.* **I. Bernfeld.** (Zeitschr. Phys. Chem. 25. pp. 46–73, 1898.)—The author investigates electrolysis with electrodes of the natural ores PbS, Fe_7S_8, $CuFeS_2$, Cu_3FeS_3, FeS_2, Sb_2S_3, MoS_2, and artificial FeS in solutions of HCl, HNO_3, H_2SO_4, NaOH, and Na_2SO_4. The following reactions are found to be general :—

1. Sulphide as anode. In acid solution, the metallic constituent is dissolved, the sulphur remains or is oxidised (by greater current-density) to sulphuric acid. In alkaline solution, the metal is turned into hydroxide, the sulphur is oxidised in various stages up to H_2SO_4.

2. Sulphide as kathode. H_2S is formed at the kathode and the metal remains; the ores usually crumble to pieces. In alkaline solution, the sulphur is dissolved as alkaline sulphide, the metal remains as sludge.

The author endeavoured to measure the resistance of galena without finding any fixed value; the temperature coefficient is negative, but no electrolysis could be ascertained. Electrolysis of PbS in NaOH showed agreement with Faraday's law. In measuring the potential of PbS and AgS constant values could only be obtained by keeping the concentration of H_2S in the electrolyte constant; natural PbS is always some 0·02 volts lower than the artificial. The variations in E.M.F., with dilution of the Na_2S solution agreed with the univalence of the active ion, from which the author is led to the following scheme of electrolysis for a concentration cell of PbS in Na_2S (saturated with PbS):—

$$\begin{array}{lr:l} & \mathrm{Pb}+2\mathrm{SH}'+ & \mathrm{HSH}+\mathrm{PbS} \\ \text{becomes} & \mathrm{PbS}+\mathrm{HSH} & +2\mathrm{SH}'+\mathrm{Pb}, \end{array}$$

the current flowing from concentrated solution to dilute, in the electrolyte, with formation of undissociated H_2S in the former and dissociated SH′ ions in the latter (Na′ ions are not represented). From this the formula

$$\mathrm{E}=\frac{\mathrm{RT}}{\epsilon}\log\frac{p'}{p}-\frac{\mathrm{RT}}{2\epsilon}\log\frac{p'_1}{p_1}$$

for the E.M.F. is obtained, where p' and p are the concentrations of SH′ ions, p'_1 and p_1 of the H_2S molecules: this was proved for varying strength of NaHS, and [roughly] for varying strength of H_2S (by expelling gas from saturated solution by nitrogen). Ag_2S and Bi_2S_3 gave similar results. The solubilities of the sulphides calculated from these potentials (with the help of the supposed chain, Metal—normal metallic nitrate—normal NaHS—metallic sulphide) gave Ag_2S $3{\cdot}4\times10^{-22}$, PbS $2{\cdot}9\times10^{-5}$, Bi_2S_3 $2{\cdot}1\times10^{-26}$.

B. B. T.

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541. *Calculation of Conductivity of Mixed Electrolytes.* **J. G. MacGregor** and **E. H. Archibald.** (Phil. Mag. 45. pp. 151–157, 1898.)—According to the dissociation theory, the specific conductivity of a complex solution, volume v of which contains N_1, N_2, N_3, ... gramme equivalents of electrolytes 1, 2, 3 .... respectively is given by the expression

$$\frac{1}{v}(a_1N_1\mu_{\infty 1}+a_2N_2\mu_{\infty 2}+a_3N_3\mu_{\infty 3}+\ldots\ldots),$$

in which a_1, a_2, a_3 .... are the coefficients of ionisation and $\mu_{\infty 1}$, $\mu_{\infty 2}$, $\mu_{\infty 3}$.... the specific conductivities per gramme equivalent at infinite dilution. The value of μ_∞ for an electrolyte in a complex solution may be taken to be the same as in a simple solution, provided the dilution is sufficient. If it be assumed (1) that any dissolved electrolyte, which is in dissociational equilibrium, may be regarded as being in this state, not only throughout the whole volume of the solution, but also throughout any finite part of it, and (2) that each electrolyte in a complex solution, with its undissociated and dissociated parts, though disseminated throughout the whole volume, may be regarded as occupying a definite portion of the volume, then equations may be formed sufficient to determine α_1, α_2, α_3 . . . . and N_1, N_2, N_3 . . . . and thus the conductivity. The equations, however, are not very suitable for working with. The authors, therefore, in order to test the theory, made up solutions of potassium chloride, sodium chloride, potassium sulphate, and sodium sulphate of equal ionic concentrations. These were then mixed in equal volumes. Since no change takes place in the ionisation, the four values of α and of N are known, and the conductivity of the mixture may be calculated. The values so found support the theory. The differences between the observed and calculated values of the conductivity, in a series of sixteen different concentrations, range from 0·7 to 0·2 per cent. W. R. C.

542. *Error in Estimating the Heat of Ionisation of Electrolytes.* **J. J. van Laar.** (Zeitschr. Phys. Chem. 24. pp. 608–614, 1897.)—The degree of ionisation of the solvent (β) as well as of the dissolved substance (α) changes with the temperature. That is to say, in the constant of Ostwald or Rudolphi

$$K_1' = K_1(1+\beta)^{\nu_2-1} . f^{\nu_2-1} \Big/ (\overset{+}{\nu_2})^{\overset{+}{\nu_2}} (\overset{-}{\nu_2})^{\overset{-}{\nu_2}},$$

the term $(1+\beta)^{\nu_2-1}$ must also be taken into account.

Thus instead of

$$q_1 = RT^2 d \log K_1/d\tau,$$

the author obtains

$$q_1 = RT^2 \{d \log K_1'/d\tau + (\nu_2 - 1) d \log A/d\tau\},$$

where A, the factor of association, $=2/1+\beta$.

This correction is important, as shown by comparing the values of $RT^2 d \log K_1'/d\tau$ already found (KCl -364 g. cal., KNO_3 -140 g. cal., etc.) with the value of $RT^2 d \log A/d\tau$ for water, which is reckoned by the author from Ramsay's measurements to -364 g. cal. at 35° C.

The above equation may be re-written for convenience

$$q_1 = \frac{\nu_2 - (\nu_2 - 1)\alpha}{1-\alpha} RT^2 \frac{d \log \alpha}{d\tau} + (\nu_2 - 1) RT^2 \frac{d \log A}{d\tau},$$

where $\frac{d \log \alpha}{d\tau}$ may be calculated from $\alpha = \frac{\mu_v}{\mu_\infty}$. Thus for KCl by 35°, q_1 is calculated to $-364 - 364 = -728$ g. cal. as above.

If we assume with Rudolphi that $\nu_2 = 1\frac{1}{2}$ (instead of 2, Ostwald) we obtain $q_1 = -524$ g. cal., from which difference the author hopes to decide between the two hypotheses. B. B. T.

543. *Electrolytic Preparations.* **K.** (Électricien, 15. pp. 59–61, 1898.)—Allusion is made to Lükow's researches. In preparing an insoluble salt, the electrolyte should consist of 80 °/。 of a soluble

salt of the anode metal and 20 °/₀ of the salt which is to cause the precipitate. For oxides, the electrolyte should contain 95 °/₀ to 99·5 °/₀ of a salt whose anion forms a salt soluble with difficulty, and 5 °/₀ to 0·5 °/₀ of a salt whose anion forms an easily soluble salt with the anode metal. Details are given for the preparation of various bodies, such as peroxide of lead, chromates of lead, basic carbonate, and basic phosphate of copper. W. R. C.

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544. *Electrolytic Bleaching and Disinfecting Solutions.* **M. C. Beebe.** (Electrician, 40. pp. 421–423, 1898.)—The author carried out experiments upon the electrolytic decomposition of magnesium and sodium chlorides with a view to determine the power required in obtaining bleaching solutions and the effect of density and temperature. He arrives at the following conclusions: (1) The amount of available chlorine in solution is not proportional to the power expended. (2) It depends upon the temperature. (3) It also depends upon the amount of the products of decomposition already formed in the solution. (4) At fairly high temperatures (50° C.) there may be an actual decrease in the amount of available chlorine per ampere-hour. (5) The amount of available chlorine per ampere-hour depends largely upon the density of the electrolyte, dense solutions giving more than dilute ones. (6) The effect of current density upon the efficiency cannot be definitely stated. (7) If the temperature is kept below 15° C. it is possible to reach a concentration of 9·7 grammes of available chlorine per litre at an efficiency of 0·9 gr. per ampere-hour, using NaCl solution of 1·100 sp. gr. (8) A dilute solution disintegrates carbon anodes much more rapidly than one that is concentrated. (9) Frequent reversal of the current to lessen polarisation and resistance greatly reduces the efficiency. (10) Polarisation for a given temperature and density of electrolyte remains constant, regardless of current density.

A number of curves are given illustrating the results. W. R. C.

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545. *Electrolytic Manufacture of Parabolic Reflectors.* **S. Cowper-Coles.** (Journ. Inst. El. Eng. 27. pp. 99–115, 1898.)—This process consists of an electrolytic method for the production of metallic mirrors from a glass or highly polished surface. The process is being used for the manufacture of parabolic reflectors for search lights. On a highly polished surface is first of all deposited a coating of metallic silver, which is thrown down chemically and then polished so as to ensure the copper backing being adherent to the silver. The mould, after silvering, is placed in a suitable ring and frame, and then immersed in an electrolyte of copper sulphate, the mould being rotated in a horizontal position, the number of revolutions being about 15 per minute. The copper adheres firmly to the silver, and together they form the reflector, which is subsequently separated from the glass mould by placing the whole in cold or lukewarm water, and

then gradually raising the temperature of the water to 120° Fahr., when the metal reflector will leave the glass mould, due to the unequal expansion of the two. The surface obtained is an exact reproduction of the surface of the mould, and has the same brilliant polish. It requires no further treatment to answer all the purposes of a reflector, with the exception that it must be coated with a film of some suitable metal such as palladium, which is found to resist tarnishing to a wonderful degree. AUTHOR.

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546. *Electrolytic Treatment of Ores.* **C. E. Webber.** (Journ. Inst. El. Eng. 27. pp. 38–99, 1898.)—The author considers the treatment of ores containing the precious metals. After dealing with the subject historically, a description is given of the Pelatan-Clerici process which is being worked at Rossland (B. C.). W. R. C.

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547. *Manufacture of Electro-Chemical Products.* (Elect. Rev. 42. pp. 333-337, 1898.)—In this article a general outline is given of the processes carried on, and the plant in use at the works of the Electro-Chemical Co., of St. Helen's. In the manufacture of caustic soda, chloride of lime, and chlorate of potash, brine is supplied through mains to the decomposing-cells from an elevated tank, so that the cells can be filled by merely turning taps. The decomposing tanks are 20′ × 3′ × 1′ 3″ deep, and are divided into 16 cells. The anodes consist of irregular blocks of carbon embedded on a lead strip fixed in an earthenware box which is inverted in the cell but does not reach quite to the bottom, so as to permit the liquid to circulate freely inside. A simple wrought-iron grid forms the kathode. The hydrogen formed is allowed to escape into the atmosphere. The chlorine passes through a port-hole in the anode-box into a closed conduit running the whole length of the tank, and connected to an earthenware main which conducts it to the bleaching-chambers and to the chlorate of potash plant. The E.-C. Co. state that they have no difficulty in maintaining their bleaching-powder at market strength, since they are not liable to trouble from CO_2. The caustic soda is purified from salt by a preliminary evaporation process, in which the salt is precipitated and removed by means of a revolving frame which shovels out the salt from the bottom of the receiving-tank. The engines were made by Messrs. Yates & Thom, and are of the marine type, compound and condensing, working at 135 lbs. per square inch. In a test they gave 1 H.P. hour for 14 lbs. steam, the average indicated H.P. being 711·35. Lancashire boilers are employed. The engines drive the dynamos through rope-gearing. These dynamos each develop 1250 amperes at 180 volts at 400 rev., and are made with Sayer's windings. The switches are worked by a system of railway-levers, and were built under Mr. Slater Lewis' patents. The distribution is effected through a bare stranded cable, joints being avoided by untwisting a strand at places where a branch is to be taken. C. K. F.

GENERAL ELECTRICAL ENGINEERING.

548. *Storage-Battery Testing.* **R. Kennedy.** (Elect. Rev. 42. pp. 386-387, 1898.)—The author discusses the loss of capacity of storage-cells which is observed as the rate of discharge is increased, and points out the necessity of testing cells at high rates of discharge as well as at low rates for the purpose of comparison. Given two cells which have the same capacity when discharged in 7 hours, it by no means follows that they will have the same (reduced) capacity when discharged in 1 hour. This fact is especially important in the case of central-station cells, which may at times be discharged at very high rates. An instance is given showing a marked improvement in the capacity of a cell at high rates, effected by structural alterations. A. H. A.

549. *Samson Primary Battery.* (West. Electn. 22. pp. 133-134, 1898.)—This cell is of the Leclanché type. The special feature is the carbon, which is made in two parts. The lower part is a thin-walled, fluted, hollow cylinder, made very porous. The top part is made of a different kind of carbon and subjected to a very high pressure. After the two parts have been baked in a kiln, the top of the carbon is made red-hot and plunged into hot paraffin. The latter thus enters into the smallest pores, and creeping of salts is prevented. A combination of manganese and pea-carbon is placed inside the fluted portion and held in position by a prepared plug. The depolarising power is said to be much greater than usual in this form of cell. W. R. C.

550. *Lalande Primary Battery.* (Électricien, 14. pp. 401-403, 1897.)—An improved form of this cell is described. W. R. C.

551. *Sentinel Circuit-Breakers.* (Elect. Rev. 42. pp. 315-316, 1898.)—In this automatic circuit-breaker, the actual disruption of the circuit is accomplished by the breaking of a brittle metal bar, by means of a released spring hammer, which is included in the circuit, and which is provided with grooves to localise and insure the break. An illustration of the apparatus is given. It is said to be very reliable. W. G. R.

552. *New Type of Circuit-Breaker.* (Elect. World, 31. p. 229, 1898.)—A circuit-breaker is now constructed by the Ward Leonard Electric Company, Bronxville, N.Y., in such a fashion that each side of the circuit in the double-pole type is separately closed. The instant the current flows, the side of the switch not held by the operator will automatically fly open and open the circuit if an overload or circuit switch exists. If an overload occurs later, after the operator has left the switch, then both poles will open

simultaneously. In both cases the circuit is instantly interrupted, and all arcing occurs on carbon. The only adjustment is that of raising or lowering a vertically movable core of a solenoid magnet. The adjustment ranges from 25 per cent. under to 50 per cent. over the current which the circuit-breaker will carry continuously. The adjustment-readings cover a long range of travel of the core, and are all well defined and easily read. W. G. R.

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553. *Electric Heating and Cooking.* **W. P. Adams.** (Elect. Engin. 21. pp. 107–110, 1898.)—In this paper the author reviews the possibilities of heating and cooking by electricity, with especial regard to cost. The apparatus required to cook for 8 to 10 persons are an oven, taking 2500 watts for the first 15 minutes and 1200 afterwards; a breakfast cooker with two circuits, each 600 w.; two grillers and two frying-pans, each 500 w., and several hot-plates, or electric saucepans, taking about 1500 w. The maximum possible demand would be 7200 w., but this is never approached in practice; the maximum demand for lighting purposes in such a household would be about 2500 w. Private consumers supplied from central stations are the most likely to adopt electric cooking; but electrical energy for this purpose must be supplied at a moderate price. The author considers that 1*d.* per unit will soon be possible, having in view the improvement of the day load, while in many cases the charge is already reduced to 3*d.* or less, and the total cost is under 2*d.* per unit. An increase of load in the summer due to the use of electricity for cooking is almost certain, as is shown by the experience of the gas companies. In a certain household of five persons, where both gas and electric cooking-apparatus were installed, the consumption of gas per week was 1240 cb. ft., costing 3*s.* 9*d.* at 3*s.* per 1000 cb. ft., and of electrical energy 30 units, costing 5*s.* at 2*d.* per unit, when either was used exclusively. The average consumption of electricity is 1 unit per head per day in small installations, but may be reduced to one-half this value in large establishments. Heating water by electricity is expensive, and a separate hot-water stove is recommended for this purpose. Where isolated plants are in use, the extra cost of energy for cooking is very small, especially if the plant be of large size; water-power installations are exceptionally well adapted for the application both of electric cooking and heating. Electrical heating is very different from cooking, as it increases the load in winter, but is not called for in summer. A fair allowance for the energy consumed is 500 watts per 1000 cb. ft. of space in very cold weather. The expense is heavy, unless energy is supplied at a very low charge; but the convenience and sanitary qualities of electric radiators somewhat counterbalance this objection. Electrical heating is recommended for use on board ship. A large number of data of generating costs, etc. are included in the paper. A. H. A.

554. *Electric Floor-Scrubber.* (Elect. Rev. N.Y. 32. pp. 83–84, 1898.)—This device, which is patented by H. F. Ackerman, of Cleveland, Ohio, consists of a frame mounted on rubber-tired wheels and carrying an electric motor. This motor drives three rectangular scrubbing-brushes mounted at the ends of vertical shafts and pressed against the floor by springs, these shafts being connected to the motor through bevel- and chain-gearing, so as to revolve at about 400 rev. per minute. A rheostat is mounted on the handle of the machine, the current being supplied to the motor by a flexible cord which may be attached to any convenient lamp-socket; the slack cord is taken up by a spring-tensioned reel mounted on an upright on the frame. The machine weighs about 300 lbs., and is about 30 in. square. By replacing the scrubbing-brushes by sandpaper blocks or blocks of stone, the machine may be utilised to dress down wood floors, the decks of vessels, or mosaic tiling. C. K. F.

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555. *Mechanical Applications of Electricity.* **G. Richard.** (Écl. Électr. 14. pp. 410–417, 1898.)—This is chiefly an account of the applications of electricity in naval matters. The General Electric Company have recently proposed a system of signalling from one ship to another by means of semaphores worked by solenoids with movable iron cores. By this arrangement it is easy to produce a different signal for each letter of the alphabet and to work the arrangement with rapidity. Messrs. Siemens & Co. have brought out a buoy carrying glow-lamps. G. Griffith has invented an electric sounder such that an electric bell is rung as soon as ground is touched. W. G. R.

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556. *The Stresses and Deflection of Braced Girders.* **W. H. Macaulay.** (Phil. Mag. 45. pp. 42–65, 1898.)—In the case of a pinned frame which has no more members than are needed to define its shape, the stresses under a given system of loading are to be found by a force-diagram, or by resolution of forces. If, however, there are additional or redundant members, forming bracing which can be removed without making the frame loose, it is necessary to take into account the elasticity and strength of the various parts of the structure. The general problem of determining the stresses in a frame with redundant members, and its deformation (assumed to be small) in any direction, under the action of given forces applied at joints, was first solved by Clerk Maxwell. His solution was published in the 'Philosophical Magazine' in 1864, and is reprinted in his Collected Papers. The only objection to it is the formidable length of the calculations, which are apt to be involved in the application of it to any but very simple cases.

The object of the investigation in the present paper is to obtain by Maxwell's method some general results for certain types of girders, and to compare them with the results given by other less exact methods of procedure. Maxwell's equations are solved for a parallel girder with N panels and N redundant members, and it is shown that, in the cases considered, the stresses and deflection can be presented explicitly in a manageable form. The comparison with the results given by the ordinary Euler-Bernoulli method for determining the deflection of a uniform beam is discussed; also the applicability of the method of obtaining stresses by regarding the girder as compounded of two simpler ones. The results for another type of girder are given, and finally the corrections for stiffness of joints are discussed. AUTHOR.

557. *Marvin's Electric Percussion Drill.* **F. H. Loring.** (Elect. Rev. N. Y. 32. pp. 156–157, 1898.)—The drill-chuck is forged in one piece with a soft steel plunger forming the core of two adjacent mica-insulated coils, which, when alternately excited, give the plunger its reciprocating motion; provision is made for slowly revolving the plunger. Instead of switches, a special single-phase alternator is used, having a drum-armature with a loop-winding, one of whose ends goes to a solid collector-ring connected to the common terminal of the coils of the drill, while the other terminates in a half-ring, which alternately shifts the current into the two sides of the drill-circuit by means of two brushes diametrically opposed to one another. The circuits are so arranged that the magnetism in the plunger is never reversed. The speed of the drill is usually about 380 strokes per minute, each stroke corresponding to one revolution of the generator. The whole apparatus is designed for mule-back transportation. E. H. C.-H.

558. *Electrical Heating and Lighting.* (Elettricità, Milan, 17. pp. 71–73, 1898.)—The paper affords some interesting figures relative to the cost of electrical heating. The following comparison well illustrates the relative economics of electric lighting and heating:—50 litres [1·76 cub. ft.] of gas produce in a fish-tail burner 4, or in an incandescent burner 20, candle-hours. The same amount of gas transformed into electric energy by means of a gas-engine and dynamo produces 16 candle-hours. The calories [large] given out by the same 50 litres are, directly 225, electrically 45. A kettle taking 550 watts boils 1 litre [1·76 pints] in 12 min. at a cost of 0·66*d.* at 6*d.* per B.T.U. A stove will maintain a room at a temperature of 22° C. above the outside temperature, supposing the air to change once every hour, with a consumption of 65 watt-hours [costing 0·39*d.*] per cub. metre capacity of room. As a measure of the surface required for a given radiation: an iron plate, inside temperature 250° C., outside 200° C., in air at 15° C., will radiate 1 kilowatt [860 calories per hour] with a surface of 0·13 sq. metres. G. H. BA.

559. *Electric Locomotive Headlights.* (West. Electn. 22. p. 92, 1898.)—This apparatus is a combined engine, dynamo, and arc-lamp, taking up a space 26″ × 18″, and weighing 250 lbs. The engine is a compound steam-turbine running at 1800 revs. per minute; the turbine-wheel, shaft, and armature run in two bearings only and weigh 42 lbs. No details are given as to steam-consumption, or of the construction of the turbine or its governor. A longitudinal section and some photographs of the apparatus are given in the original paper. C. K. F.

560. *Electrically-operated Power Dredges.* (Elect. World, 31. pp. 291-293, 1898.)—One of the most trying applications of power-developing machinery of any kind is that to power dredging and shovelling apparatus. A complete equipment of this kind, using electric motors throughout, has been developed by the Bennett Amalgamator Manufacturing Company, and put to use in Colorado in placer-mining work. By means of three motors the turn-table carrying the boom and dipper can be turned about a vertical axis, the dipper handle can be raised or lowered through the boom, and the dipper itself can be rotated about the joint of the dipper handle and boom. In operation the turn-table is swung to a suitable point for scooping up a dipperful of gravel. The dipper is lowered until its handle is about in a vertical line, when the bottom closes with a bang and latches automatically; the dipper is then run down in the gravel, and is pulled up and forward by the hoisting cable, thus scooping up a load of earth. The turn-table is then swung until the dipper hangs over the hopper of the amalgamator, which is driven by a motor mounted on the platform of the car, the power being transmitted by means of a heavy steel sprocket-chain.

In connection with the amalgamator a motor-driven pump is employed which is capable of delivering 1600 gallons of water per minute under 100 pounds pressure. Another motor of 15 horse-power is placed on the car-body, and connected with a centrifugal pump which receives the overflow from the amalgamator-tank. The power is supplied by a 150-kilowatt dynamo. The motors are all run at 500 volts. The whole arrangement is so simple that one man can manage it. W. G. R.

DYNAMOS, MOTORS, AND TRANSFORMERS.

561. *Dynamos of Recent Design.* **C. F. Guilbert.** (Écl. Électr. 14. pp. 361–367, 1898.)—The author gives an illustrated description of the following new types of continuous-current dynamos:—(1) A Ferranti machine with external revolving field-magnet and brushes, and stationary armature. The field-magnet consists of a ring of iron with inwardly-projecting pole-pieces on which are wound the exciting coils. Into this ring is fitted another—the pole-ring—which is slotted to receive the compensating winding and to furnish reversing pole-pieces; whereby the machine is enabled to work with constant lead without sparking. (2) A variable-speed motor, designed by J. V. Sherrin, in which both field-magnet and armature are made movable. By applying a brake to the field-magnet, the armature speed may be varied. (3) A unipolar dynamo due to F. E. Elmore. The armature consists of a solid cylinder of iron which passes through the ring-shaped pole-piece of the field-magnet, and which is provided with two collars (one on each side of the field-magnet) from which the current is collected by a large number of balls which run in grooves between the collars on the armature-cylinder and two pairs of fixed collars arranged on either side of them; the frictional losses, which in this type of machine are usually heavy, are thereby materially reduced. The magnetic flux passes radially into the cylinder, then divides, one half going axially along the cylinder in either direction, and then emerging radially once more into a ring-shaped pole-piece which is bolted to the bed-plate and which completes the magnetic circuit. (4) A. W. Smith's dynamo, characterised by the peculiar arrangement of the field-winding, the extreme lightness of the field-magnet, and short air-gap. [A full description of this machine by the inventor will be found in 'The Electrician' for Oct. 8th, 1897.] (5) A constant-potential, variable-speed dynamo, patented by C. H. Wade, J. Moores, and H. O. Farrell, which is intended for the lighting of vehicles or carriages while in motion. The armature-coils are not connected direct to the commutator, but through an arrangement of multiple-contact switches by means of which the number of active turns in each armature-coil may be varied. The multiple-contact switch is actuated by a centrifugal governor in such a manner that more turns are thrown into the circuit as the speed decreases. (6) Several alternative forms of chord-winding due to S. G. Brown (and similar to Mordey's). (7) A six-pole drum-wound dynamo by the Compagnie de l'Industrie Électrique de Genève, in which the field-magnet is annular in shape, and is provided with a single exciting coil. The outer portion of the annular field-magnet is furnished with three pole-pieces (of same polarity) projecting in an axial direction and spaced 120° apart, the magnetic circuit being completed through the armature-core and a solid cylinder of iron which supports it. A. H.

562. *Parallel Operation of Compound Dynamos.* **G. T. Hanchett.** (Elect. World, 31. p. 220, 1898.)—A compound dynamo is wound so that the field-excitation increases with the load on the machine in order to compensate for drop of voltage due to (1) reduction of the speed of the dynamo; (2) the internal resistance of the machine; (3) the demagnetising action of the armature-currents; and (4) the resistance of the conductors from the dynamo to the point at which constant potential is desired. It follows that compound dynamos coupled in parallel and unequally loaded will fail to regulate for line loss with accuracy. This could be remedied by having in addition to the usual series coil, a separate series coil carrying only the main current, or a portion of it. If the main current is not too large, the separate series coils of the several machines could all be placed in series with the line, but in the case of a heavy line-current they would be coupled in parallel. These coils would be permanently in the circuit and would serve to give the initial excitation. W. G. R.

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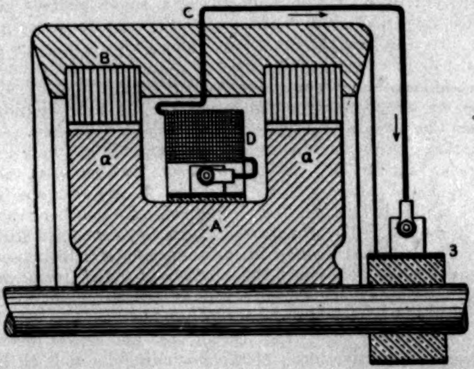
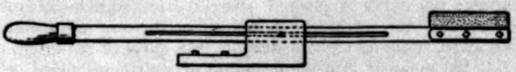
563. *Routin's Self-Exciting Alternator without Commutation.* (Elect. World, 31. p. 182, 1898.)—This is a method, due to J. L. Routin, of obtaining the excitation current for alternators without the use of exciters or rectifiers of any sort. The application particularly described is that of an inductor alternator of the type shown in the accompanying figure, where A represents the rotor with polar terminals, *a a*, revolving inside the fixed magnetic return, B, on the laminated annular projections of which the induced coils are wound. The poles may be axially in line with each other, or staggered, and the machine may be either single or multiphase. The line C shows diagrammatically the course of the conductors in which the exciting current is generated by the unipolar action of the rotating magnetic field in the fixed magnetic



yoke B. This conductor, C, leads from the brushes bearing on an external collector-ring shown at the right-hand end of the shaft, through the core B, to and through the field-winding D, and thence to an internal collector-ring on the rotor A, the two collector-rings being connected either by an insulated conductor or the iron mass itself. W. G. R.

564. *Sand-papering Generator Commutators.* (Street Rly. Journ. 14. p. 13, 1898.)—This is a description of a device due to J. D. Lynch of Hestonville, by which holding sand-paper against the commutator by hand is avoided. The arrangement consists of a bracket of wrought iron $\frac{3}{8}$ in. thick, held against the pillar-block of the engine by four lag-screws. Inside this bracket a long iron bar with forged lever and slot running almost its entire length is held by means of a bolt. The sand-paper is fastened to a wooden block at the end of this bar. The method of holding the bar in the bracket keeps the sand-paper in a plane at right angles to the diameter of the commutator, so that the surface of the latter will always be flat. The accompanying figure is an elevation of the device. W. G. R.



ELEVATION OF DEVICE FOR SAND PAPERING COMMUTATORS

565. *Windings of Polyphase Armatures.* **J. P. Stone.** (Amer. Electn. 10. pp. 10–11, 1898.)—The most interesting part of this paper is on the choice of armature windings according to the requirements of the machine. In some cases the triangle-winding is preferable, and in others the star-winding. The latter adapts itself more readily where rectified current is used for compounding, since the commutator can be connected to the common junction of the three phases. The triangle-winding is essential in generators which shall combine direct-current output or input with alternating-current output or input, such as a rotary converter, where, on account of the direct-current feature, the winding must be of the triangle form. Also, by choice of one or the other winding it is often possible to make a better motor both mechanically and electrically. An armature designed for a given working voltage, measured between the lines, would, if planned for star-winding, have fewer turns of larger wire than if intended for triangle-winding. The triangle-winding, on the other hand, has more turns of small wire, as the current is diminished while the E.M.F. in each coil is the full E.M.F.

between the lines. This property is useful under certain conditions, as it makes the E.M.F. between any two lines somewhat less. W. G. R.

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566. *Starting of Non-Synchronous Single-Phase Motor.* **G. B. Maffiotti** and **F. Pescetto.** (Elettricista [Rome], 7. 3. pp. 53–59, 1898.)—The paper treats of the Brown type of motor, which the authors consider as a rotary-field motor, the second component of the rotary field being induced by the armature field. The following problem is proposed :—Given the maximum torque the current being constant, and given the torque required at starting, to find the best value of the resistance in the armature circuit: the best value being that for which the initial speed required to start the motor is a minimum.

Taking the formula

$$k = \pi . \mathrm{N} . \mathrm{B}^2 . \mathrm{A}^2 . \left\{ \frac{r(n-m)}{r^2 + 4\pi^2 \mathrm{L}^2 (n-m)^2} - \frac{r(n+m)}{r^2 + 4\pi^2 \mathrm{L}^2 (n+m)^2} \right\},$$

where k is torque, n speed of rotation of field, and m that of armature; the curve is plotted between k as ordinate and m as abscissa, and the envelope of this curve for varying armature-resistance, r, is found to be a straight line through the origin and through the point of maximum torque at maximum speed, when $m=n$. The point on the line corresponding to the initial starting torque required gives the minimum initial speed which must be given to the armature; and from this may be calculated the resistance in the armature circuit corresponding to the curve touching the line at this point. Since at the lower torques the ordinate of the point of contact is less than the maximum ordinate of the curve, the motor, once the minimum initial speed has been given, is on a rising curve and will run up speed till it passes the maximum and reaches a stable point. Resistance can then be cut out of the armature circuit until the maximum torque has increased to its normal value. G. H. Ba.

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567. *Alternate-Current Motors.* **L. B. Atkinson.** (Engineer, 85. pp. 218–219, 1898.)—The author divides alternate-current motors into four classes:—(1) Conductive motors, in which the energy is conveyed to the armature through brushes. (2) Inductive motors with brushes, having one inductive electric axis and one magnetic axis: in these the energy is supplied to the armature through the air-gap. (3) Inductive motors with brushes, having two reciprocal inductive electric and magnetic axes. (4) Inductive motors without brushes, having short-circuited coils and two reciprocal inductive electric and magnetic axes: this is the modern induction-motor.

The monophase induction-motor was evolved from such motors by eliminating the supply on one phase whilst running. Asynchronous motors can be used as generators and motor-generators. Passing on to the question of design, the author gave a formula for determining the proper loading of the armature, and derived all the other dimensions of the motor therefrom. Tests, curves, and data of actual motors of the different classes are given. Also curves showing relative weights of motors for continuous current and for single-, two-, and three-phase currents.

E. H. C.-H.

568. *Applications of Alternating Motors.* **A. G. Davis.** (Elect. World, 31. pp. 25–28, 1898.)—The author considers generally the application and working of alternate-current motors.

W. R. C.

569. *Graphical Determination of Transformer Efficiency.* **A. Russell.** (Electrician, 40. pp. 720–722, 1898.)—The paper contains an account of a useful graphical method of determining the efficiency of a transformer at various loads from the following data:—

V_1 = primary P.D.

W_0 = watts absorbed by transformer on open secondary.

$Q = R_1 + R_2 \frac{S_1^2}{S_2^2}$, where R_1 and R_2 denote resistances of primary and secondary coils, and $\frac{S_1}{S_2}$ = ratio of turns in primary and secondary respectively.

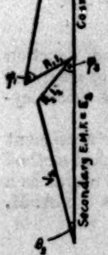

FIG. 1.

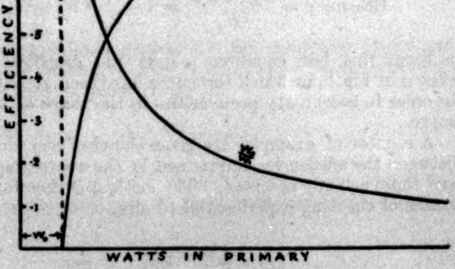

FIG 2.

Referring to Fig. 1, in which I_1 and I_2 stand for primary and secondary currents respectively, we see that, neglecting magnetic leakage,

$$E_1 = \frac{S_1}{S_2} E_2,$$

and that $\cos\theta_1$ and $\cos\theta_2$ are practically each $=1$; so that

$$V_2 + R_2 I_2 \cos\phi_2 = \frac{S_2}{S_1}(V_1 - R_1 I_1 \cos\phi_1). \quad . \quad . \quad . \quad (1)$$

The magnetising turns remaining practically constant, it follows that

$$I_2 \cos\phi_2 = \frac{S_1}{S_2}(I_1 \cos\phi_1 - I_0 \cos\phi_0),$$

where I_0 and $\cos\phi_0$ refer to the primary current and power-factor on open secondary. If W_1=watts supplied to primary, the last equation may be written

$$I_2 \cos\phi_2 = \frac{S_1(W_1 - W_0)}{S_2 V_1}. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

From (1) and (2) we find

$$V_2 = \frac{S_2 V_1}{S_1}\left\{1 - \frac{QW_1}{V_1^2} + \frac{S_1^2}{S_2^2} R_2 \frac{W_0}{V_1^2}\right\} \quad . \quad . \quad . \quad (4)$$

Since in any commercial transformer the term $\frac{S_1^2}{S_2^2} R_2 \frac{W_0}{V_1^2}$ is very small (being generally much less than ·001), we may write

$$V_2 = \frac{S_2 V_1}{S_1}\left\{1 - \frac{QW_1}{V_1^2}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Hence we find, using (3) and (5),

$$\text{Efficiency} = \frac{V_2 I_2 \cos\phi_2}{W_1} = 1 - \frac{Q}{V_1^2}(W_1 - W_0) - \frac{W_0}{W_1}.$$

From this last equation follows the graphical construction shown in Fig. 2, in which the losses have been greatly exaggerated in order to accentuate peculiarities in the shape of the efficiency-curve.

A number of examples are given showing very close agreement between the efficiencies determined by the above graphical method and those actually observed. The method is therefore useful as a means of checking experimental results. A. H.

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570. *Rotary Transformers.* **J. E. Woodbridge** and **C. T. Child.** (Elect. World, 31. pp. 216–218, 1898.)—This is a continuation (see Abstract No. 204) of the investigation of the heating-effect of the currents in a rotary converter, the two-phase rotary being now dealt with.

If C is one-half the direct current through the brushes, V the direct voltage between the brushes, then

V = maximum instantaneous alternating voltage ;

$\frac{V}{\sqrt{2}}$ = virtual alternating voltage between diametrically opposite collector-rings ;

$\frac{C}{\sqrt{2}}$ = virtual alternating-current in either phase (assuming a power-factor of unity);

C = maximum instantaneous alternating-current in one phase; and

$C\sqrt{2}$ = maximum instantaneous combined alternating-current in the armature winding.

If ϕ is the angular distance between the middle point P of a quadrant of the armature and one of the direct-current brushes, and α the angular distance between any conductor on the active surface of the armature and the point P, the direct-current in it is C and the instantaneous alternating-current $\sqrt{2}C \sin \phi$; hence the rate of heating is

$$\{C - \sqrt{2}C \sin \phi\}^2 r = C^2 r(1 - 2\sqrt{2} \sin \phi + 2 \sin^2 \phi),$$

where r is the resistance of the conductor. To find the total effect during one-half a rotation, this expression must be integrated between the limits

$$\phi = \alpha \quad \text{and} \quad \phi = \pi + \alpha ;$$

whence the average heating-effect is

$$C^2 r\left(2 - \frac{4\sqrt{2}}{\pi} \cos \alpha\right).$$

The ratio of this heating-effect in the conductor under consideration to the heating, if the machine was generating the same direct-current load, is therefore

$$2 - \frac{4\sqrt{2}}{\pi} \cos \alpha.$$

To get the average heating-loss throughout the armature, a second integration must be performed with respect to α between the limits

$$\alpha = \frac{\pi}{4} \quad \text{and} \quad \alpha = -\frac{\pi}{4},$$

and the result divided by π: thus

Average heating-loss throughout the armature

$$= \frac{1}{\pi}\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} C^2 r\left(2 - \frac{4\sqrt{2}}{\pi}\cos a\right) da$$

$$= 2 - \frac{16}{\pi^2}$$

$$= 0{\cdot}38.$$

Thus, under the conditions assumed, any direct-current machine used as a two-phase rotary, will dissipate as C^2r armature-loss only about 38 per cent. of the energy wasted when working as a generator at the same output. If K is the safe transforming capacity for such a machine, then

$$0{\cdot}38\,K^2 r = C^2 r,$$

or

$$K = 1{\cdot}62\,C.$$

Hence, with power-factor unity, the rating of a two-phase rotary transformer may be 62 per cent. greater than that of a direct-current generator or motor of the same dimensions. W. G. R.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

571. *Motive Power from Tides.* **P. Bunet.** (Électricien, 15. pp. 114-115, 1898.)—An attempt has been made at the little port of Ploumanach (Côtes-du-Nord) to utilise the tides for motive purposes. This has been rendered the easier since at high tide the water overflows into some natural pools at a much lower level separated from the sea by a kind of bank. This drop of water is used to drive a waterwheel to which a dynamo is geared. By the use of accumulators a constant supply of electrical energy is thus available. W. G. R.

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572. *Transmission Plant of the Apple River Power Company.* (Elect. World, 31. pp. 186-188, 1898.)—At the small town of Somerset on Apple River, Wisconsin, an electrical plant has recently been installed for the purpose of transmitting electrical energy 7 miles to New Richmond, where are located a number of mills which had hitherto been using steam-plants for the power they required. The city is also electrically lighted, and the Apple River Power Company, before it began operations, obtained a contract for doing all the city lighting and pumping for the city water-supply, besides several contracts for power for mills, elevators, etc.

The water-wheels installed are of the most improved horizontal type, designed to run at 130 revolutions per minute and to develop 231 horse-power on an 18-foot head, with an efficiency of 80 per cent. The turbines are twin 42-inch machines, by which the end-thrust is neutralised, mounted on a horizontal 6-inch shaft, and discharging into a double quarter-turn cast-iron central draft-chest fitted with a draft-tube 7 feet in diameter and 8 feet long running into a wheel-pit 12 feet deep. The electrical apparatus consists of one 250 kilowatt, 6000 volt, three-phase alternator of the inductor type; two 2½ horse-power 125 volt exciters; one 100, one 50, and one 30 horse-power two-phase brushless-type motors; one 25 horse-power brush-type motor; five 50 kilowatt and two 25 kilowatt 5500 volt three-phase to 220 volt two-phase, self-ventilating oil-transformers; and six sets of 6000 volt Wurts combination choke-coil non-arcing metal lightning-arresters.

The full potential of transmission is generated in the alternator, so that transformers are used only at the distributing end of the circuit to reduce the voltage from 5500 to 220 volts, and are specially designed with a lead from the middle of the secondary wires. The two outside transformer terminals are connected with the old Edison 220 volt outside wires, and the extra lead from the transformers to the middle wire of the Edison system, allowing the use, as before, of 110-volt lamps without any further change in the system that was already installed. W. G. R.

573. *Electric Transmission in a Lithographic Establishment.* (Amer. Electn. 10. pp. 1–9, 1898.)—In this article the electrical installation of the American Lithographic Company of New York is described at length, and the special advantages of the electrical system in this connection are discussed. The generating plant consists of two 200 kw. dynamos coupled direct to Corliss engines, and one 40 kw. set; the larger dynamos have smooth-core armatures with disc commutators and ten-pole fields, compound wound for 1740 amps. at 115 volts, 120 revs. per minute, and weigh 24,500 lbs. each. The lighting and power circuits are supplied by separate feeders, protected by armoured conduits, and run in roomy wire-ways specially provided for the purpose. About 140 motors are used, varying in size from 2 to 35 H.P., and having a total capacity of 847 H.P.; slow speed and direct coupling are used throughout. The motors driving the presses are of the ironclad series-wound type, supported from the press frame by cast-iron brackets, and are provided with heavy fly-wheels and electric brakes. A separate controller is used for each motor, giving 5 speeds by varying the field-winding; certain machines are also fitted with push-buttons and relays for stopping the motor in case of urgency. Groups of small machines used intermittently are driven by belts from short lengths of shafting; the motors for this purpose are suspended from the ceiling girders and are shunt-wound, with one speed only. Each motor is provided with an automatic cutout, which in the case of the shunt motors places the starting-switch in the "off" position if the circuit is opened. The presses are lighted with enclosed arc lamps, by means of which colours can be matched as well as by daylight.

The plant has been at work for 6 months with perfect success; the average load is 0·54 of the maximum, and the load-factor 17·6 per cent. The consumption of coal averages 4·45 lbs. per E.H.P. hour. The cost per unit of manufactured product shows a saving of 44·2 per cent. of the cost in former years.

The article is fully illustrated, and a sheet of details drawn to scale is inset. A. H. A.

574. *A Recent New England Railway.* (Street Rly. Journ. 14. pp. 151–155, 1898.)—This article describes the Torrington and Winchester Street Railway, a country line of 13½ miles of single track, put into operation on July 1, 1897. Full abstracts of the specifications are given under the headings Track and Overhead Construction, Power Station, Engines and Generators, Boilers, Power Station Apparatus, Car Equipment, Cars. The total cost

of equipment and construction up to date is 363,000 dollars, including 13,000 dollars for a Park, etc. The earnings of the 5 closed and 8 open cars for the first 6 months were 25,000 dollars.

E. H. C.-H.

575. *Paderno Electric Transmission.* (Elettricità, Milan, 17. pp. 133-136, 1898.)—The paper gives a description of the three-phase generators erected in the power-transmission station at Paderno, and explains the reasons determining the choice of type and system.

The 2160 H.P. machines, constructed by Brown, Boveri & Co., generate directly at 13,500 volts with a frequency of 42 periods, their speed being 180 revs. per min. The type with rotating field-magnets was selected in preference to the inductor type of machine, on account of the latter's large magnetic leakage and consequent large internal reaction, which, for a joint supply of light and power, renders regulation difficult. The internal reaction of the existing machines is guaranteed to be not over 5 °/₀ on non-inductive load, and 16 °/₀ on an inductive load with power factor of 80 °/₀. The efficiencies in the two cases are respectively 95 °/₀ and 93 °/₀.

To mention a few structural details:—The armature is capable of rotation so as to bring any portion into a convenient position for repairs. The windings are passed through tubes of micanite-paper, these tubes projecting 10 cms. beyond the iron to guard against discharges to the carcass. The field-magnet consists of 28 cast-steel poles on the periphery of a fly-wheel, each pole being surrounded by a single thick copper helix, with paper insulation between the spirals.

G. H. Ba.

576. *Alternating Current Regulation.* (Elect. World, 31. pp. 218-219, 1898.)—The difficulty in regulating the voltage at an alternating current station which supplies current for induction-motors and other inductive apparatus is well known. Messrs. Steinmetz and Rice have taken out a patent for an arrangement by which leading currents are introduced into the line to such an extent as to neutralise the lagging component caused by the inductive apparatus connected with the mains. The arrangement is based on the known fact that an induction machine, when driven at a speed greater than that corresponding to synchronism with the main current, acts like a condenser and superimposes a leading component on the main current. By proper adjustment this leading current can be made to balance any lagging current present. The induction-machine is connected to the mains as a motor, and then mechanically driven at a greater speed than corresponds to synchronous running.

Another patent recently taken out by E. W. Rice, Jun., depends upon the known fact that a highly excited synchronous motor acts like a condenser and produces leading wattless currents. W. G. R.

577. *Dover Traction and Lighting Station.* (Lightning, 13. pp. 95–97, 1898.)—This is an account of the combined traction and lighting station at Dover. For lighting purposes alternating current is generated at 2000 volts and transformed down to 100 volts. The total capacity of the alternators is 325 kilowatts. The arc-lamps are suspended from light arches thrown across the streets, which are narrow. The Parade was illuminated last season by strings of incandescent lamps suspended from wires looped along the Front.

The traction-plant consists of two 100-kilowatt General Electric six-pole dynamos coupled direct to horizontal McIntosh and Seymour engines. The voltage is 500 and the speed 235 revolutions per minute. There is also a 30-kilowatt motor-alternator wound for about 2000 volts and 100 periodicity on the alternator side, and 500 volts on the continuous side. This machine is to be used if required to run one or two cars late at night when the traction-plant has ceased running. W. G. R.

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578. *Polyphase Motors in Electric Traction.* **C. P. Steinmetz.** (Elect. World, 31. pp. 20–21, 1898.)—After some general remarks upon the relative advantages of direct-current motors, used in conjunction with rotary transformers, and polyphase motors, the author goes on to consider the control of the latter. Three methods are available:—(1) Rheostatic control; (2) tandem-multiple control; (3) potential regulation, with short-circuited armature. The advantages and disadvantages of rheostatic control are the same as on the direct-current system. This also applies to tandem-multiple control. Potential regulation is the simplest method, the impressed E.M.F. being varied by means of a transformer of variable transformation. Unfortunately, in this case, the motor efficiency is lower than that with rheostatic control, and the torque per ampere is very low at starting. Unless the drop in the line is very small, the motor is liable to fail to start. Thus this method is generally unsuitable for railway-work. The author concludes with a brief summary of the advantages and disadvantages of polyphase motors as compared with direct-current motors for traction purposes.
W. R. C.

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579. *Electric Traction in Kansas City, U.S.A.* (Street Rly. Journ. 14. pp. 67–72, 1898.)—The Metropolitan Street Railway Company of Kansas City operates 136·5 miles of single track, of which about 71 miles are electric lines, the remainder being worked almost entirely on the cable system. There are four electric generating stations, the most modern of which is described in detail. This station furnishes power to 77 cars, as well as to the workshops 2½ miles away; the average output and cost of working per month for four months in 1897 are given as follows:—

Kilowatt-hours output, 310,338.

Engineers, oilers and firemen	$471·77
Repairs to machinery	83·35
Oil and waste	40·94
Fuel	870·55
Water	26·91
Miscellaneous	19·09
Total	$1512·61

Average cost of one kilowatt-hour, $·004874.

One of the cable-lines, 4½ miles long, is operated by a 300 kw. electromotor in a substation, supplied from the principal generating station 1·7 miles distant; the detailed costs of working of this plant and of the steam-plant formerly used are given, and show a saving of $660 per month, or about 64 per cent.

About 5000 cast-welded joints are in use on old rails, with excellent results. In the newer construction 103 lb. rails are used, cast-welded and bonded with copper bonds; the rails are laid on wooden blocks in trenches 20 in. × 12 in. deep, which are then filled up with concrete under and around the rails and topped with granite blocks. A. H. A.

580. *Electric Traction in Switzerland.* **C. Rochat.** (Street Rly. Journ. 14. pp. 99–103, 1898.)—Notwithstanding the abundant water-power available for Electric Railway development in Switzerland, this mode of traction has not reached an expansion proportional with that in some other countries, principally because there are few large cities in Switzerland, and consequently the need of urban rapid transit has not been felt to any great extent. The electric railways actually in operation in Switzerland have a total length of 110·517 km. The first put in operation, in 1888, was that of Vevey-Montreux Chillon, which had a length of 10·49 km.

A table is given showing the rate at which electric traction has grown in Switzerland since 1888, which shows that the principal increase has been in the last three years. Every indication is that in two years the length of electric track will be double that at present.

Considering the kind of motive power at the central stations, the Swiss tramways can be subdivided as follows:—

15·593 km. or 14·2 °/₀ are operated by steam.
71·176 km. or 64·5 „ „ water-power.
23·748 km. or 21·3 „ „ gas-engines.

The total capital invested at the end of 1896 in electric tramways was 16,455,801 fr. for 81·614 km. of lines, or on an average 201,664 fr. per km. of line.

To facilitate comparisons the principal data of the Swiss tramways are given together in two tables, of which the following is an abstract:—

Location of Tramway.	Length in km.	System of Trolley.	Gauge in metres.
Vevey-Montreux	10·49	Shuttle.	1
Sissach-Gelter Kinden	4	Wheel.	1
Grütsch-Mürren	4·279	„	1
Stansstad-Stans	3·455	Sliding shoes.	1
Chavornay-Orbe	4	„ „	1·435
Genève	20·010	„ „	1·435
Zurich Ville	4·52	Wheel.	1
Zentrale Zürichberg	3·53	„	1
Bâle	8·66	Sliding bow.	1
Lugano	4·494	Two wheels.	1
St. Moritz	1·64	Wheel.	1
Aubonne Allaman	2·60	Sliding shoe.	1
Lausanne	10·844	„ „	1
Chaux de Fonds	1·35	Sliding bow.	1
Alstätten-Berneck	11·565	Wheel.	1
St. Gall	9·190	Sliding bow.	1
Neuchâtel	5·268	Wheel.	1
Fribourg	1·460	Sliding shoe.	1
Zurich-Oerlikon	5·500	Wheel.	1

The tramway and railway lines actually in construction at the present time number twelve, with a length of 103·060 km. The lines for which franchises have been granted, but which are not yet in course of construction, number 25 with a length of 322·705 km.

The author deals with the general character of the construction of the lines under different headings:—

Track Construction.—Information is given relating to types of rails and gauge. The track-switches employed are of two types—those with one movable point and those with two. Each of these types is manufactured automatic and non-automatic. General practice is in favour of automatic switches with two movable points, which give an easy passage to the car and one without shocks. The usual minimum space allowed between the outside of the car and stationary objects along the track, such as houses, trees, etc., is 1 m. An exception, however, has been made in favour of the poles for supporting the overhead wire, and the authorities permit for this a minimum clearance of ·6 metre.

Overhead Construction.—This is varied according to the system of contact employed, viz. trolley wheel, rubbing bow or shoe. A number of views are reproduced in the course of the article which give a good idea of the various modes of construction. Useful information is given with regard to trolley-wires and regulations relating to its installation. Also to the types of insulators employed, to lightning arresters, and to telephone disturbances.

Current and Voltage.—Up to 1895 continuous current only was employed in Switzerland, as elsewhere, for electric tramways. Since that time the tri-phase alternating current has come to practical use, and installed for the first time at Lugano. The potentials which have been used up to the present have been 550 for the continuous and 450 for the alternating. This year, however, several Lines of considerable length are making a study of the question of voltage, and, after a consultation with the Government Railway Department, a new law was adopted in 1897 by which this voltage has been increased, the maximum being fixed under three different headings. The question of proper voltage was debated to a great extent, and the passage of the law was preceded by a number of tests carried out by Prof. H. F. Weber, of which details are given, to determine if possible the voltage dangerous to the human body. These decisions, which have now become law, will permit an important saving in the construction and operation of electric railways. L. J. S.

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581. *The Steel* 30 *H.P. Traction-Motor.* (Street Rly. Journ. 14. p. 59, 1898.)—This motor is remarkable for its light weight—1200 lbs. only. The motor is of the cast-steel enclosed type, with 4 poles of laminated wrought iron; the frame is in two parts joined by links. Four field-coils are used, wound on formers and held in spring holders. The armature is of small diameter, with a hollow core, and is wound with 33 coils in as many slots; the wires are driven into slots in the commutator lugs, without the use of solder. The motor is primarily intended for electric traction; other sizes are made, from 25 H.P. to 150 H.P. A. H. A.

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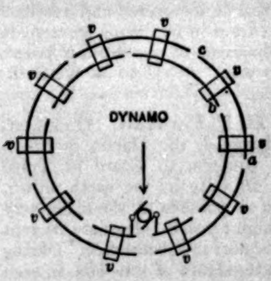
582. *High-tension Direct Current Traction.* **A. Blondel.** (Elect. World, 31. pp. 21–23, 1898.)—The author proposes to employ direct current for long-distance traction by running the trains in series. For this purpose the conductors are erected in sections, as indicated in the figure. Two conductors are, of course, necessary in this system, and the breaks are made alternately so that any break in one conductor is opposite the centre of the section of the other. Calling *ab* one section of the line, then the circuit is complete so long as one train, indicated by *v*, is upon each section, and thus all the trains will be working in series. A difficulty occurs in maintaining the continuity of the circuit as a train passes from one section to the next. This, however, may be overcome by arranging that a train shall not pass from any given section until a second one has run on to it: in other words, the number of sections must be less than the number of trains running at any time.



When two trains get on one section they each only receive half the normal current, which might result in a slowing-down or even stoppage. It would therefore be necessary to employ two groups of motors on each train to be put in series, or motors with two windings. Change in headway, say to double the number of trains, would be effected by doubling the current and running two trains in parallel. The headway could be increased by the use of switches for coupling sections together.

The figure refers to a loop-line only. But a line which is not looped could be worked in the same manner by using four conductors as a flattened loop.

This method of working possesses all the advantages common to a series system. By running eight cars each requiring 500 volts and 20 amperes, with the station at one end, a saving of 50 % in copper would result. There are no doubt objections to the system, but the advantages are considerable. W. R. C.

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583. *Electrical Repairs of Railway Motors.* **M. R. McAdoo.** (Street Rly. Journ. 14. pp. 11–13, 1898.)—The author having come to the conclusion that the cost of electrical repairs of railway-motors is usually excessive, invited A. B. Herrick to devise a method of simple electrical tests which would indicate completely electrical weaknesses in motors before the occurrence of an actual breakdown.

The method consists in making tests when the controller is (1) on the first point; (2) on the series step on the series-parallel controller, or on the parallel step where a rheostat is used; and then ground connection is removed and the insulation of the equipment is taken. These three tests are sufficient to show whether the equipment is in good condition or not. If these tests show that the motor is faulty, a more detailed test is required to locate the fault. If these inspectional tests are regularly made, an incipient fault will be discovered and rectified at much less cost than would be incurred in rectifying a complete breakdown. The paper contains diagrams of the testing board, with accessories and instructions for use. W. G. R.

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584. *Dublin Electric Tramways.* **H. F. Parshall.** (Engineer, 85. p. 219, 1898.)—As originally designed, the Dublin Southern Tramways installation would not conform to Board of Trade requirements, as it gave a drop of 20 volts in the earth return. The problem was to utilise as much as possible of the machinery already ordered. Three-phase, high-tension alternate-current system was adopted, with motor generators in substations. During nearly two years of operation, the attendance of one boy in each station has sufficed: the low-frequency motors made synchronising easy. Instead of the 20 cars originally contemplated, sixty could now be worked on the line, the fall of potential then being only 3½ volts. The line is commercially interesting, as illustrating the

development of traffic by improved service. The working costs show that, even with the small units, the system is fairly efficient, but the chief claim for it is the ease and reliability of its operation.
E. H. C.-H.

585. *Electric Tramways at Dover.* (Lightning, 13. pp. 8–10, 1898.)—This is a detailed account of the electric tramway at Dover, which is of the overhead trolley type. The wires are at a height of 21 feet 6 inches above the road. The current is purchased from the Dover Electricity Supply Company (see Abstract 577). The total cost of the undertaking is about £28,200. During the season the takings amount to about £26 per day. The length of the line each way is about two miles, and the fare for the single journey is one penny. The running cost does not exceed £18 per day, so that the undertaking is a financial success. Both electrically and mechanically, everything seems to have succeeded beyond expectations. W. G. R.

586. *Rail-Bonding.* **E. T. Birdsall.** (Street Rly. Journ. 14. pp. 18–19, 1898.)—The author discusses at length the subject of rail-bonding, and emphasises the necessity of increased cross-section and contact-surface as compared with present practice; he advocates constant inspection and testing in order to ensure the maintenance of the joints in good condition. A bond devised by the author consists of stranded copper conductors with cast copper contact-plates, which are soldered to the underside of the rail-ends; the cross-section is equivalent to that of a 70 lb. rail. This bond costs about $1·25, applied in place. A. H. A.

587. *Kenway's Overhead Trolley-System.* (Elect. Engin. 21. pp. 333–334, 1898.)—This system aims at reducing the side bracket-arm to a minimum, and increasing the length of the trolley-arm in proportion. Only one trolley-wire is used for single or double track, and contact is made with it on the side by a vertical sliding-bar at the end of the adjustable pivoted trolley-pole. When cars meet, the trolley-arm of the outer car is supposed to be guided over that of the inner arm by star-shaped discs on the vertical sliders, but doubt is thrown on the feasibility of this at high speeds. The inventor has yet to show how convex curves are to be negotiated, and how difficulties due to variation in the relative heights of trolley-wire and slider are to be overcome.
E. H. C.-H.

588. *Trolley-Car Service on the Brooklyn Bridge.* (Elect. World, 31. pp. 179–180, 1898.)—The construction of tracks and the operation of the Brooklyn electric cars across the great suspension bridge is remarkable on account of its solidity of structure and the ingenious mechanism for controlling the switches and signals. Bonding is effected by a continuous copper cable of 175,000

circular mils section laid in the side-groove of the rail. The overhead construction is of remarkable solidity. The trolley-wire, of "figure eight" cross-section, is supported on flexible pole-brackets, spaced only 37 feet 6 inches apart. The feeder-cables are eight in number, each of 500,000 circular mils, and are carried on heavy glass insulators mounted on small brackets inside the through-trusses in which the car-cables run. Seven of these cables are positive feeders, while one of them acts in conjunction with the rails and rail-cables as a return-feeder. The track-switches are of the well-known variety made by the New York Switch and Crossing Company, and will be electrically controlled by interlocking electric switches in the signal box. It is expected to maintain a headway of 15 seconds with a speed of 7 miles an hour, thus keeping the cars a little over 100 feet apart.

W. G. R.

589. *High Speed Electric-Truck.* (Street Rly. Journ. 14. p. 167, 1898.)—The Peckham "Metropolitan Special" Truck, which is here illustrated, is designed for extra-long, high-speed cars, being guaranteed to handle 22 ft. closed cars, and 32-ft. open cars at 25 miles per hour without oscillation. The framework is extra strong, and under-tension springs are provided at the ends to check oscillation. 150 of these trucks are running on the Madison Avenue line in New York. E. H. C.-H.

590. *Trolley Pole-Catcher.* (Street Rly. Journ. 14. p. 59, 1898.)—A device is described for catching the trolley-pole when the trolley-wheel leaves the wire, so as to prevent injury to the overhead construction, etc. The rope attached to the pole is wound on a reel in the catcher, and is held taut by a coiled spring which yields to slow movements; but if the pole rises suddenly, as when the wheel runs off the wire, the reel revolves rapidly and throws out dogs which instantly stop the motion. The catcher is usually fixed on the dash-board of the car. A. H. A.

591. *Peckham Trucks.* (Street Rly. Journ. 14. pp. 113–114, 1898.)—These swing-bolster double-trucks are described and illustrated. "14 A" is designed for high-speed suburban traffic, and "14 B" for elevated railways with sharp curves. Both aim at keeping the car-body as low as possible to facilitate ingress and egress. The bolster is carried on a spring plank by one half-elliptic and two spiral rest-springs, the plank itself being supported through rubber cushions by four links; these links incline slightly outwards when the car is at rest, and centrifugal force on curves therefore tilts the car, and has the same effect as superelevation of the outside rail. The "14 B" can be made with 45 in. wheel-base, but for 4 ft. 8½ in. gauge, not less than 4 ft. 6 in. wheel-base is recommended. E. H. C.-H.

592. *Emergency Pavement-Brake.* (Street Rly. Journ. 14. p. 110, 1898.)—This consists of an eccentric spool or cylinder, mounted near the middle of the car, which, when lowered on to the pavement, is revolved by the motion of the car till it lifts the truck-frame about 2 inches, thus bringing nearly the whole weight of the car on to steel brushes, which act on the shaft of the spool. The device is not intended to replace wheel brakes, but is for use in slippery weather, or on steep grades. It does not injure the pavement. E. H. C.-H.

593. *Emergency Brake.* (Street Rly. Journ. 14. p. 113, 1898.)—This brake is specially suitable for a runaway car on a steep grade. By means of bevel gearing, the motor-man can exert about 3000 lbs. downward pressure on a steel fork on the end of a threaded shaft, causing it to enter the ground, one prong on each side of the rail. It is claimed that this will not wreck or derail the car. E. H. C.-H.

594. *Kingsland's Surface-Contact System.* (Elect. Rev. 42. pp. 359–360, 1898.)—Contact-rails or studs are connected on to the main conductor through two switches in series. In their simplest form, these switches consist of two contact-plates and a sliding contact-bar operated by a lever. Each contact-bar rocks between two pairs of contact-plates and controls the circuits of two adjacent studs. The one operation of pushing over the lever disconnects the stud behind from the mains, and at the same time connects the stud in front. For ordinary street work, the sliding contact-bar of the switches takes the form of a cylindrical commutator, which is rocked by an electromagnet, worked as a shunt off the mains. This apparatus is buried in a water-tight box 8×10 inches. Advantages claimed for the system are that the switches have no springs and require no force to hold them in position; no equipment of cells or electromagnets on the cars is necessary to operate the switches, and should a switch fail to cut-out, the car cannot proceed. E. H. C.-H.

595. *An Improved Sand-box.* (West. Electn. 22. p. 146, 1898.)—The novelty in the "Ham" sand-box of the Electric Appliance Co. of Chicago, is the absence of any valves at the bottom of the box. Underneath the opening of the hopper is a curved shelf, over which a paddle is reciprocated, thus forcing the sand over the ends of the shelf into the feed-spouts. E. H. C.-H.

596. *Electric Car Details.* **E. C. Parham.** (Amer. Electn. 10. pp. 29–30, 1898.)—This article forms one of a series, complete in themselves, dealing with the precautions to be observed in equipping a truck, and the course to be pursued in car-wiring from trolley-wheel to hood-switches. The latter are provided as a means of breaking the circuit, should accident disable the con-

troller: hence are safety devices. After dealing with the wiring of the car, the lightning arrester is considered. In same cases the arrester is tapped-on the trolley-wire before it enters the fuse-box, and in others it is tapped-on afterwards: neither method seems to affect the arrester's efficiency.

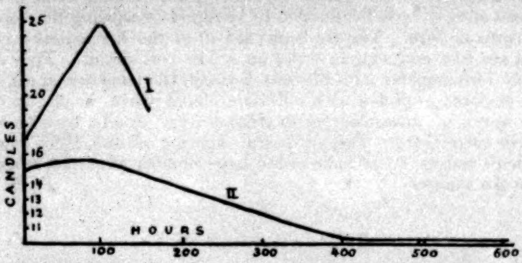
The author gives full notes with regard to the coupling up and installing of controllers, and to the care to be observed in the splicing of joints. In the fixing of connections, it must not be forgotten that upon receiving a load the car-body lowers three or more inches. Also that when wiring a car having radial trucks, the connections must be placed where the car-wheels cannot reach it when turning a curve. When a brake is put on the brake-rods rise, and all wires must be well out of their way. L. J. S.

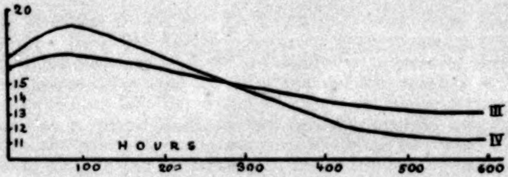
597. *Changing a Cable-Conduit to an Electric Conduit.* (Street Rly. Journ. 14. pp. 37–39, 1898.)—This is an account of the methods employed in substituting electric traction for the cable system at Washington, D. C., U.S.A. Scale drawings are given, showing the alterations required to adapt the cable conduits to electrical working; these are being made *in situ*. As the slot-rails were unprovided with lips to shed water clear of the electric conductors, a 1 in. × 1 in. angle-iron was riveted to the lower edge of each rail throughout its length; special tools were devised for drilling the holes and holding the rivets in position while being headed. The working conductors are iron T-rails weighing 21 lbs. per yard, bonded together; porcelain insulators are used, cemented into iron caps. A brief account of the generating plant is also given, as well as a more detailed description of the construction of the car-trucks. A. H. A.

598. *Incandescent Lamp-Filaments.* **J. C. Shedd.** (Amer. Electn. 10. pp. 105–106, 1898.)—The paper contains an historical review of the gradual evolution of the modern incandescent-lamp filament. A. H.

599. *Nernst Incandescent Lamp.* **H. Lux.** (Elect. World, 31. p. 335, 1898.)—The paper is a brief account of Nernst's experiments on the use of substances like chalk, magnesia, kaolin, etc. as materials for incandescent-lamp filaments. These bodies may be considered as practically non-conducting at ordinary temperatures. When raised to a high temperature, they become conducting, and are further characterised by the large proportion of visible light-rays which they emit. Nernst has succeeded in obtaining ·96 candle per watt with a hollow filament of magnesia. The greatest difficulty in the way of a practical application of these facts lies in the very poor initial conductivity of the material, which has to be raised to a high temperature by some independent means before it will conduct appreciably. Alternating currents must be used in order to prevent electrolytic action on the material. A. H.

600. *Lamp Life and Efficiency.* **E. F. Gibbon.** (Elect. World, 31. p. 357, 1898.)—The author gives curves, reproduced below, showing the results of a number of tests carried out by him on lamps in actual service. This is a fairer test than one carried out in a laboratory, as the lamp is subjected to the extra strains arising from fluctuations in the voltage of the mains. Curves I and II refer to lamps which were rated as 108 volt 16 c.p. 56 watt lamps; and curves III and IV relate to 108 volt 16 c.p. 50 watt lamps. The author points out that the lamp to which curve I refers was rated above its normal voltage, the life being only 150 hours. The best result is that indicated by curve III. A high-efficiency lamp would, however, be quickly destroyed on a poorly-regulated circuit. The author emphasises this fact, and recommends the frequent use of portable voltmeters for ascertaining the P.D. at various points of the distributing system. A. H.





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601. *The Lighting of the Place du Théatre.* **J. Reyval.** (Écl. Électr. 14. pp. 461–465, 1898.)—The Place du Théatre-Français is lighted by arc-lamps from an alternating current-circuit, the frequency being 88 complete periods per second. An underground transformer-chamber is established in the square, and contains a large Labour transformer with double secondary circuit, the primary volts being 2400, and the secondary volts 110 on each

circuit. This transformer is provided with two circuit-breakers immersed in oil, a Patin interrupter, and an arrangement for earthing on the Cardew system. The secondary current at 110 volts is divided between two groups, each containing two circuits—a permanent circuit on which the lamps remain lighted all night, and another on which the lamps are extinguished at 1.30 A.M. In the lamp-circuit are placed variable Midoz choking-coils, a type which allows the self-induction to be varied by altering the number of turns of wire. The arc-lamps are all of the Kremenezky type, and are two and two in series on a 110 volt circuit. They consume 14·5 amperes with 33 volts between the lamp terminals, and are enclosed in globes with reflectors placed above the arc, so that the curve of intensities approximates very closely to that of a direct current-arc. The successful lighting of the Place was a difficult matter, on account of the large number of streets running into the square. W. G. R.